DECEMBER 1959

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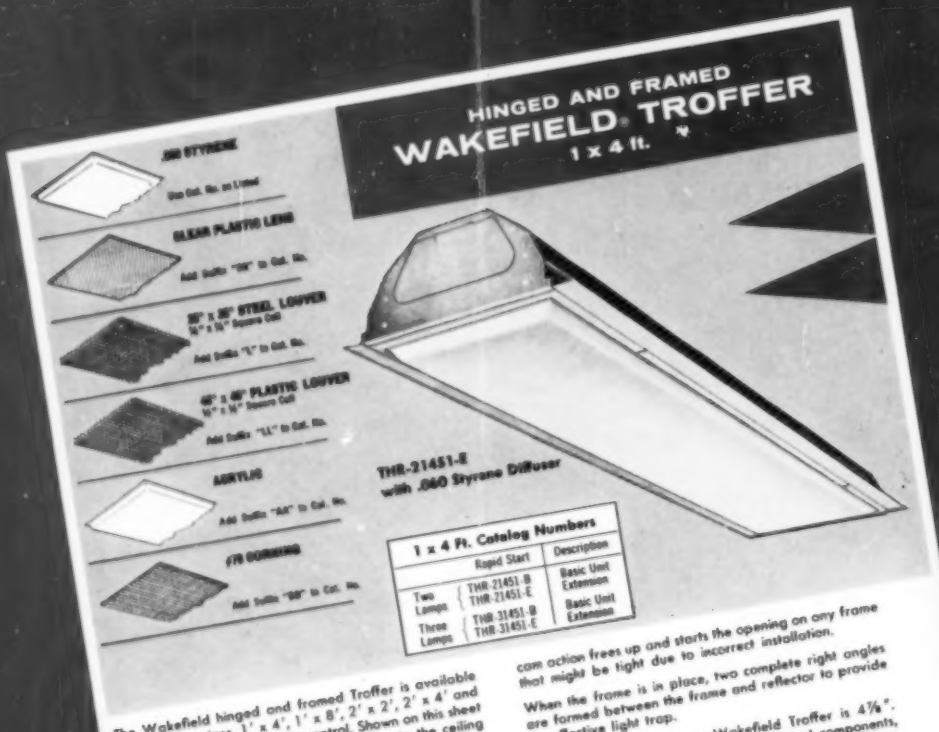
ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

Information You Can Use



1 x 4 Ft. Catalog Numbers		
	Rapid Start	Description
Two Lamps	THR-21451-B	Basic Unit
	THR-21451-E	Extension
Three Lamps	THR-31451-B	Basic Unit
	THR-31451-E	Extension

The Wakefield hinged and framed Troffer is available in 5 modular sizes, 1' x 4', 1' x 8', 2' x 2', 2' x 4' and 4' x 4', with 6 types of light control. Shown on this sheet is the 1' x 4' size. The unit is adaptable to the ceiling constructions illustrated on the reverse of this page. The hinged and framed diffusers disconnect from the Troffer for easy on-the-floor cleaning and will not fall when swinging free. The hinge may be inserted on either side of the Troffer and is invisible when the frame is in place.

The Com-lever lock is a positive device to hold the diffuser frame in place. The lever is inconspicuous and the cam action frees up and starts the opening on any frame that might be tight due to incorrect installation.

When the frame is in place, two complete right angles are formed between the frame and reflector to provide an effective light trap.

The over-all depth of the Wakefield Troffer is 4⅞". The body is 20 gauge steel. All electrical components, ballasts, sockets and wire carry UL/CSA labels. Ballasts are CBM listed. Reflecting surfaces are infra-red baked enamel with 0.84 reflection factor. Four foot module units do not grow in length when used in continuous rows.

LIMITATIONS:
Check recessing depth and compatability of unit with ceiling type.

SPECIFYING POINTS FOR ARCHITECTS AND ENGINEERS:
Body 20 gauge steel. Invisible hinge that works on either side. Frame held in place with cam-lever lock that starts opening action.

FLOOR REFLECTANCE

Ceiling	80%			70%			50%		
Walls	50%	30%	10%	50%	30%	10%	50%	30%	10%
Room Index	Coefficients of Utilization								
J 0.6	0.28	0.24	0.22	0.27	0.24	0.21	0.27	0.24	0.21
I 0.8	0.35	0.31	0.28	0.34	0.31	0.28	0.34	0.30	0.28
H 1.0	0.39	0.35	0.33	0.39	0.35	0.33	0.38	0.35	0.32
G 1.25	0.43	0.40	0.37	0.43	0.39	0.37	0.42	0.39	0.37
F 1.5	0.46	0.43	0.40	0.46	0.42	0.40	0.45	0.42	0.39
E 2.0	0.50	0.47	0.44	0.49	0.46	0.44	0.48	0.46	0.44
D 2.5	0.52	0.50	0.47	0.52	0.49	0.47	0.50	0.48	0.47
C 3.0	0.54	0.51	0.49	0.53	0.51	0.49	0.52	0.50	0.48
B 4.0	0.56	0.54	0.52	0.55	0.53	0.51	0.54	0.52	0.51
A 5.0	0.57	0.55	0.53	0.56	0.54	0.53	0.55	0.53	0.52

NOTE: The coefficients of utilization are based upon data given in Illuminating Engineering, p. 141, Vol. 48, 1953, The Zonal Method of Computing Coefficients of Utilization and Illumination on Room Surfaces.

This is one of several dozen "spec" sheets, printed on both sides, giving concise data on Wakefield's many commercial and industrial lighting units. We'll be glad to send them to you.

WAKEFIELD

THE WAKEFIELD COMPANY—VERMILION, OHIO
WAKEFIELD SOUTHWEST COMPANY — OKLAHOMA CITY, OKLA.
WAKEFIELD LIGHTING LIMITED — LONDON, ONTARIO

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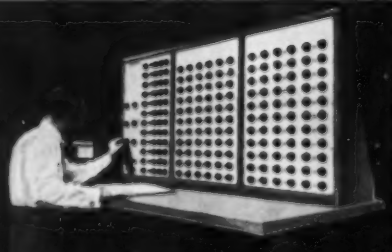
24 pages of vital information involved in classroom lighting and lighting other school areas. Explains how much light students require for easiest study. Illustrates with photos and text the effects of glare and brightness. Gives recommended reflectance values for proper seeing conditions within classrooms.

* PRICE TO GENERAL PUBLIC $1.00

A comparison chart of different types of lighting fixtures is included in the Classroom Lighting section. Many types of fixtures commonly used for areas other than classrooms such as libraries, labs, shops, auditoriums, gyms, are illustrated and recommendations for use given at the end of Section Two.

Write for your copy today.



Many problems discussed in this book were solved by Smoot-Holman's advance design analogue computer. This new computer, the only one of its type ever built for commercial use, solves problems of fixture design, as well as many other problems in the field of lighting.

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

December 1959

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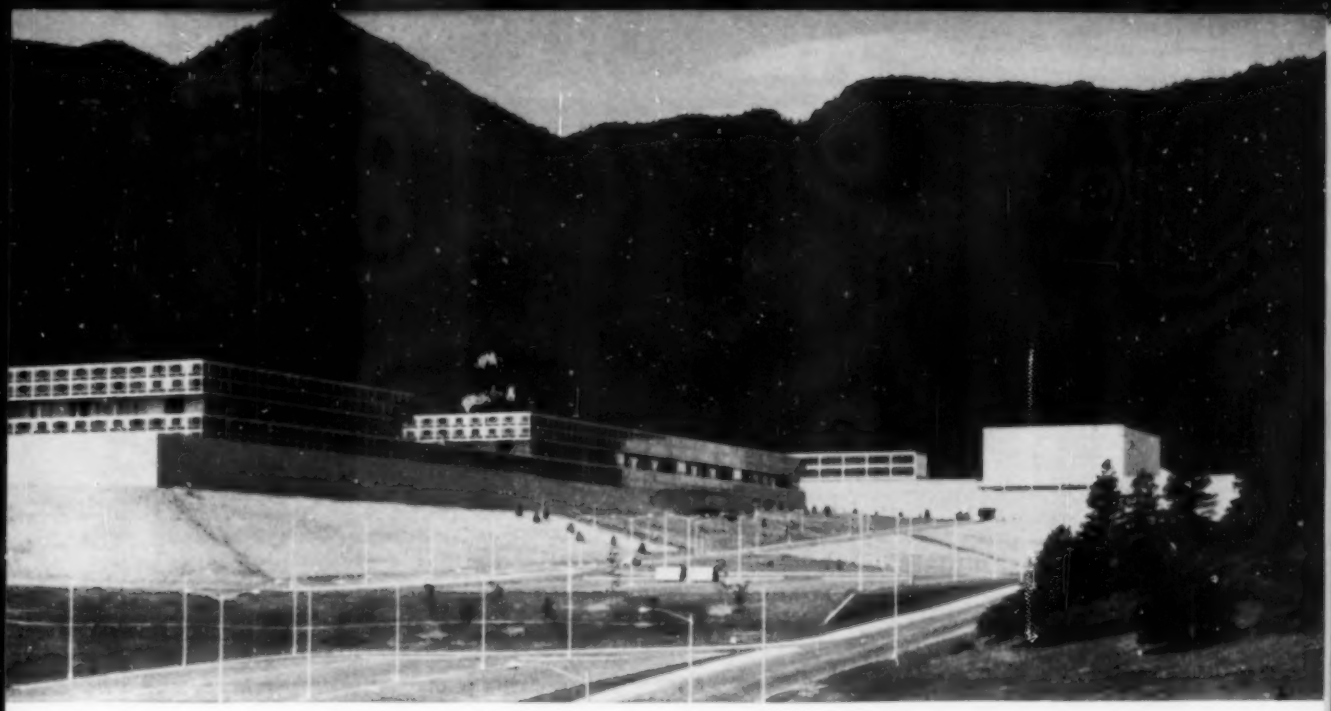
United States Air Force Academy, Colorado Springs . . . dramatically positioned with the Rampart Range of the Rocky Mountains as a backdrop.

Architects & Engineers: Skidmore, Owings & Merrill.

Electrical Engineer: Syska & Hennessy, Inc.

Fairchild Hall where open floors give a semblance of flight. The outside corridors are illuminated by special corner fixture troffers using lenses to direct light outward.

Cafeteria in the headquarters building in the service and supply area. Here flush mounted troffers with curved lenses assured a pleasing lighting effect of low brightness luminescence.



A monument to tomorrow...

The Air Force Academy

Complemented by AllBrite Lighting in Keeping with the Space Age

A calvacade of contrast . . . that's the Air Force Academy near Colorado Springs.

Buildings of aluminum, glass and white marble in military order seem to march down a mesa of broad terraces. There are buildings within buildings, separated by courts. All in all, there is earthbound strength in their precise arrangement. Yet, a sense of air and flight permeates structures that stand on stilts. Here and there floors are left completely open. Colored walls of glass mosaic read as vertical planes to add illusion of height.

This feeling of the future challenged imagination in illumination so unusual effects were sought. In one instance open floor areas were illuminated by special AllBrite corner troffers using lenses which gave light an outward direction, adding to the semblance of flight. In another, an office area was bathed in low brightness luminescence to create an unusually restful atmosphere. This was achieved by AllBrite troffers with curved lenses.

Thus did architects Skidmore, Owings & Merrill wed lighting to the total design concept of a monument to tomorrow . . . and with special skills and products AllBrite engineering served the architects well. Curtis-AllBrite Lighting, Inc., AllBrite Lighting Division, 352 Shaw Road, South San Francisco, California; Curtis Lighting Division, 6135 West 65th Street, Chicago 38, Illinois.

East end of the headquarters building in the service and supply area. Lighting was achieved by troffers with curved lenses which assured an unusually restful atmosphere.

CURTIS

visioneers in planned lighting

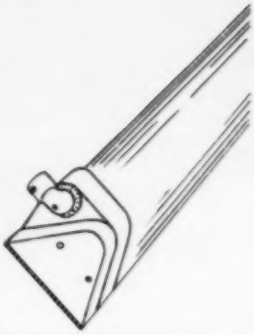
All-Brite

Revere Outdoor Lighting Report

Lighting a truck loading dock

The Problem: To light the entrance of a trucking depot loading dock. Light level must be high enough for safety and for precise parking of large trucks.

The Answer: Revere Fluoresign Outdoor Luminaires were installed over the doorways insuring safety, security and providing ideal visibility. This made nighttime parking as safe, fast and easy as daylight parking. The depot's eight entrances and its entranceway were lighted at the level of 12 to 15 footcandles with the all-weather fluorescent luminaires. Adjusting Fluoresign for best light spread can be done with lamps in and burning.

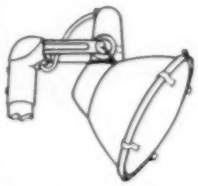


No. 8650 Series
Fluoresign Outdoor Luminaire

Lighting a tennis court

The Problem: To make night tennis play possible by providing the high level of uniform light required for good visibility in this high-speed game.

The Answer: Revere 4200 series floodlights mounted on Revere hinged poles were installed to provide the high level of light desired. Poles down the center of the courts have four floodlights, directed in pairs toward adjacent courts. Poles around perimeter of the court area have two floodlights each. Mounting height for all floodlights is 30 ft. Installation gives average maintained illumination of 13 footcandles.

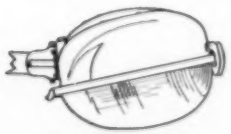


No. 4200 Series Floodlight

Lighting a shopping center parking lot

The Problem: To illuminate a large parking lot for safety in driving and parking, ease in locating parked cars, and to make the shopping center look more inviting.

The Answer: Revere Endoval Mercury Luminaires were used to illuminate driving lanes, and Revere No. 3350 Series Floodlights were installed to provide high-level illumination of 1.1 average maintained footcandles for the parking areas. The equipment is mounted on Revere hinged poles, using Revere brackets and arms. The hinged poles permit easier, safer, and more economical maintenance and relamping from the ground. Pole spacing is 150 ft.



No. 2282 Endoval
Mercury Luminaire

No. 3350 Series Floodlight

Write for Revere's complete catalog of outdoor lighting equipment

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In Canada: Curtis Lighting, Ltd., Leaside, Toronto, Ontario

Living-dining zone plan with engineering balance of comfortable general lighting, special area design, variety of effects. Two wall-length valances conceal 8 four-foot 40-watt rapid start warm white deluxe fluorescent lamps, on dimmer. Entertainment can be sparkled by two pinpoint spots over leading edge of sofa and these together with two tubular 40-watt incandescent lamps on upper side of a fluorescent fixture channel, provide ample reading light. Further interest is added by two ceiling-mounted 150-watt eyeball spots which highlight face of white Georgia marble fireplace.

Planned Home Lighting

NATIONAL ENTRY
CLASS I

Al Natalie

Oregon Section

Pacific Northwest Region

Mr. Natalie, Pacific Power and Light Co., Portland, Ore., won first prize in the Pacific Northwest Regional contest with this job.

As EVERY judge of an IES contest knows, residential entries pose as interesting an engineering problem as can be found in lighting—perhaps more so considering the hard-to-define additional considerations for individual decor.

Planned home lighting requires careful attention to living zone, family activities and illuminating engineering problems. Here is a home which qualified for national competition through its total engineering design — for comfort, convenience, safety and beauty.

The home is located in Portland, Ore., on a lot 100 by 95 feet. Total area of the house is 3170 square feet—2010 square feet on the first floor, 1700 in the basement level. The enlightened builder, Way Lee, named and promoted the house as "The Masterpiece." His plan for zoned living, specifically for modern family activities is an interesting design concept. The bid for a masterpiece, however, owes much to Mr. Natalie's engineered lighting plan. A few of the areas in the house are shown on these pages; all other spaces are similarly lighted to a definite plan.

In the dining end of the living-dining zone, a pull-down track light may be dimmed for variety of effects. This uses three 60-watt lamps. Note decorative hanging fixture beside fireplace at right. This is an Indian import, using 40-watt lumiline lamp. It provides very little light but adds a great deal of decorative charm.

"Food preparation zone"—kitchen, that is, makes interesting use of combined light sources. "Rug sized" six-foot square surface mounted luminous panel for general lighting (see cut below for full view) uses twelve 75-watt incandescent lamps.

Inside view of kitchen. In addition to luminous panel ceiling, there are two recessed floodlights over sink. One 60-watt lumiline lamp is located in range hood to provide illumination for built-in range panel. Undercabinet lighting is supplied by four 40-watt rapid start lamps for high levels on specific kitchen tasks.

"Sleeping and sanitation zone" includes three bedrooms, two baths, using similar lighting plans. Valances on two walls use 40-watt rapid start fluorescents, dimmer controlled. For reading in bed, four 40-watt tubular incandescent lamps separately switched have been added, as in the living room, at the top of the valance. A portable lamp is also provided, and a 150-watt recessed lamp lights the dressing table (not visible).

Luminous cove, with two 40-watt rapid start lamps over mirror and wash basin is the plan for this bathroom. The shower has a recessed 60-watt lamp.

Recreation zone includes playroom, sunroom, bar, workshop—and, shown here, a heated swimming pool surrounded by lighted patios and gardens. Under the eaves, recessed 75-watt floodlamps are at ten-foot spacing. Mushroom fixtures located in the garden shrubbery provide an attractive and safe night recreation area, made completely private by a surrounding fence.

NATIONAL ENTRY
CLASS II

From the main floor . . .

No Bargains

USING a basement level in a department store for merchandising quality goods *could* be a bad decision. The traditional stereotype of a basement with crowds pushing and pulling for bargains is not easily countered. But Fowler's remodeled department store in Cheyenne, Wyo., jumped this formidable psychological hurdle by making their new lower level even more attractive than the store's street-level floor.

Fred H. Rosenquist

Rocky Mountain Section

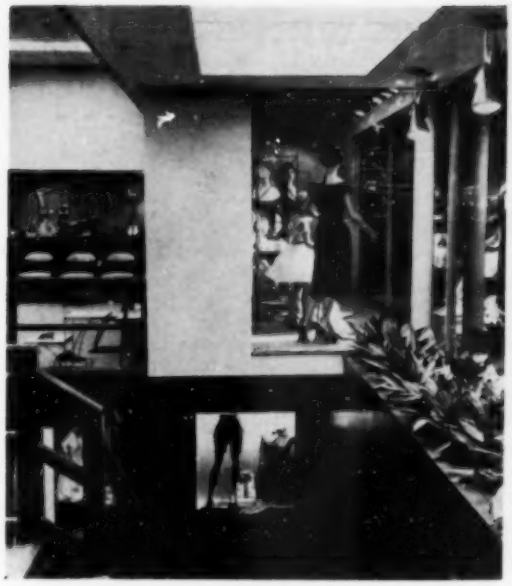
Inter-Mountain Region

Mr. Rosenquist is with Public Service Co. of Colorado, Denver, Colo. His installation for Fowler's department store copped first place honors in the Inter-Mountain Region's MMILJ contest.

A high level of illumination and the judicious use of color in the basement area combine to produce an attractive purchase-inducing environment and, at the same time, work to channel the shoppers into various well-delineated departments. Walls in this area are blue, yellow and salmon (45 per cent RF), ceiling is off-white with a reflection factor of 80 per cent, floor is light gray spatter (20 per cent RF). For a decorative change of pace, display racks are wrought iron and white with brass hardware. Light oak display tables have gleaming white tops. Even the lighting fixtures have felt the touch of paintbrush — gray and brown for the surface-mounted units and a rainbow of colors on the pendent-mounted accent units.

Two- by four-foot four-lamp surface-mounted fluorescent units supply a general lighting level of 60 footcandles in the selling areas. Deluxe cool white 40-watt rapid-start fluorescent lamps are used. Louvering is by ⅜- by ⅜-inch plastic cells with 45-degree shielding.

Fixtures mounted on the diagonal in broken rows contribute to the "department" feeling and help to guide shoppers to the various areas. Extra high-



down the stairway . . .

to Fowler's new lower level.

In This Basement

lighting for merchandise on display is obtained from either fluorescent cornices or recessed downlights with 150-watt PAR 38 lamps.

No dark spots stop the shoppers as they wander through this basement area. Levels on the steps between departments were boosted by the installation of recessed incandescent downlights.

The street-level floor at Fowler's is used primarily for the display and sale of smaller items—accessories, lingerie, children's clothing. Here, two- by four-foot four-lamp fluorescent troffers are recessed in the furred down acoustical tile ceiling (80 per cent RF) 11 feet 6 inches above the floor, to provide a general lighting level of 40 footcandles. As with the units on the lower floor, lamps are 40-watt rapid-start cool white deluxe and shielding is from ⅜- by ⅜-inch plastic louvers. Troffers are installed in broken rows on approximately ten-foot centers.

Walls on the main floor are beige and pink with 35 per cent RF; showcases are of light oak, 45 per cent reflection factor.

Focused on the merchandise displays is a higher level of illumination from PAR 38 150-watt incandescent lamps in fixed and eye-ball recessed downlights. In the main floor footwear department (partly visible in stairway pic) shoes are on view in 100 footcandles of light from the recessed polished brass eye-ball units.

To lead customers from the main floor to the lower level, a dropped canopy was extended out from the shoe department over a well-lit (100 fc) attractively designed stairway area. A four- by twelve-foot coffer in the canopy with twenty 40-watt rapid-start fluorescent lamps, shielded by plastic louvers, supplies the unusually high level of light on this well-trod stairway. A planter beside the stairs is marked for special notice by perforated brass pendent-mounted incandescent units.

All show windows facing the street have louvered ceilings and are lighted by incandescent fixtures interlocking into electrical raceways. Lamps are 200-watt PAR 46. The lighting for two small eye-level windows for special displays, located at the entrance to Fowler's lower level, is from 150-watt PAR 38 downlights. Shielded fluorescent was installed in all main floor display cases.

There is general agreement among the citizens of Cheyenne that Fowler's lower level is a far cry from the old-time bargain basement. Of course, many factors have contributed to this impression—the lighting in no small way.

An Iodine Incandescent Lamp with Virtually 100 Per Cent Lumen Maintenance

By E. G. ZUBLER
F. A. MOSBY

This paper will describe the theory and operation of a new type of incandescent lamp which employs iodine in a regenerative process in which evoporated tungsten (W) is redeposited on the filament, resulting in approximately 100 per cent lumen maintenance and increased life. While the concept of using a halogen such as chlorine (Cl_2), bromine (Br_2) or iodine (I_2) in a lamp to prevent blackening is not novel, the difficulties associated with the regenerative process have previously precluded its practice. For the first time these difficulties have been overcome and a practical lamp employing iodine in a regenerative cycle can be produced.

A SURVEY of the patent literature indicates that in 1882 a patent (No. 254,780) was issued for the inclusion of a small quantity of Cl_2 in a carbon filament vacuum lamp. Since then, a series of patents have appeared covering the use of I_2, Br_2, Cl_2 and mixtures thereof in both incandescent and discharge lamps. It is interesting to note that early patents proposed that the halogen reduced blackening during operation by reacting with the evaporated W to form a more transparent halide layer on the bulb wall. In 1923, a patent (No. 1,552,128) was issued for the inclusion of an alkali halide which supposedly reacted with impurities such as Ni and Fe on the bulb wall to form transparent halides, and reacted with the evaporated W, returning it to the filament in a regenerative cycle.

Our present efforts were initiated during the developmental work on the tubular quartz heat lamp. Small quantities of I_2, added to the usual Ar filling gas, were found to be very efficacious in preventing blackening during normal and over-voltage operation. This work led to the discovery of the necessity for correlating certain critical relationships in order to achieve successful operation of the regenerative cycle.

Iodine Cycle

In general, I_2 is being used in an incandescent lamp to prevent blackening and enhance life by redepositing evaporated W on the filament. During normal operation of an incandescent lamp, W is transferred from the filament to the wall by normal evaporation and diffusion or via the water cycle.[1] I atoms produced by the pyrolysis of molecular I_2 in the vicinity of the filament diffuse to the wall and under the proper conditions react with the adsorbed W, forming a voltatile WI_2 which diffuses to the filament. The WI_2 is decomposed on the filament, resulting in the deposition of the W on the filament and the production of I atoms which then diffuse to the wall to repeat the cycle.

Consequently, the iodine cycle depends on the reaction:

$$W + 2I \rightleftharpoons WI_2$$

where the forward reaction predominates at the wall while the reverse reaction predominates at the higher temperatures of the filament. WI_2 may also be formed in the gas phase as a result of a reaction between W(g) and I atoms (or I_2) with an inert gas molecule removing the excess energy. The relative amounts of WI_2 formed in the gas phase and on the wall are not known. Thermodynamic considerations indicate that the WI_2 is decomposed on filament rather than in the gas phase in the vicinity of the filament. The surface decomposition of the WI_2 is attested experimnetally by the success of the I_2 cycle in coiled-coil filament lamps.

The iodine cycle has been extensively studied in the developmental lamp shown in Fig. 1. This particular lamp is a nominal 500-watt, 120-volt tubular, quartz lamp, 10 mm in diameter and 95 mm in length, containing 600 mm of Ar and approximately 1 μ mole of I_2 which, if the I_2 were completely vaporized at room temperature, would give a partial pressure of approximately 4.5 mm. The filament operated at 3000K and the wall temperature was approximately 600C. This developmental lamp contains a coiled W filament, spiral W supports, a

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: General Electric Co., Cleveland, Ohio. Accepted by the Papers Committee as a Transaction of the I.E.S.

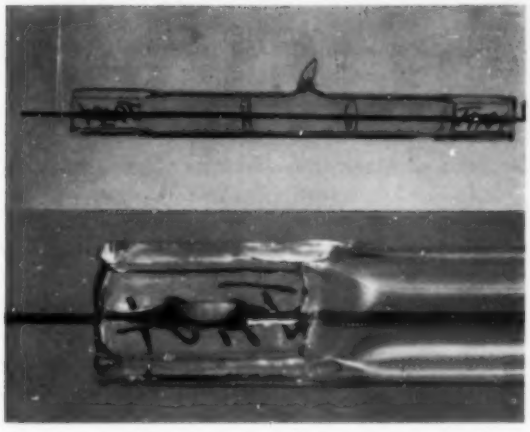


Figure 1. A 500-watt quartz iodine lamp and an enlargment of the pinch seal.

W inner lead welded to Mo foil and an Mo outer lead. With the successful operation of the I_2 cycle, the developmental lamps showed no blackening during operation, *i.e.*, with a filament temperature of approximately 3000K, and most lamps had 100 per cent of initial lumens at the end of life. A typical lamp at burnout is shown in Fig. 2. Since W was being returned to the filament, the life was increased and consequently a higher filament temperature was possible at the same life in the absence of I_2.

The remarkable efficacy of the I_2 cycle in removing adsorbed W from the surface of a quartz bulb is shown in Fig. 3. The top photograph shows a lamp that was blackened by operating the filament at a high temperature under vacuum. The lamp was then filled with the desired I_2-Ar mixture and sealed off. Below, is the same lamp after 60 seconds of normal operation. The W was almost completely removed from the wall in 30 seconds.

Wall Temperature Requirements

It has been found that the I_2 cycle will operate successfully with the bulb wall temperature in the range of approximately 250-1200C. Ordinarily, the reaction between W (solid) and I_2 requires a temperature of 700C.[4] The fact that the cycle does operate with the wall temperature considerably below 700C indicates that the reaction occurs between W and I atoms (as opposed to molecular I_2), produced by the pyrolysis of molecular I_2 near the filament. The reaction between the adsorbed W and I atoms is primarily dependent on the availability of I atoms at the wall, while wall temperature is relatively unimportant. The lower limit of the bulb wall temperature is determined by the desorption of the WI_2. If the bulb wall temperature is below this limit, a brown deposit of WI_2 is formed and the cycle is interrupted, resulting in subsequent blackening. The upper limit is determined by the stability of the WI_2 molecule on the wall. At high temperatures, the reverse reaction, $WI_2 \rightarrow W + 2I$ will be favored and the W will not be removed from the wall. This fact is important in considering the attack of the supports and leads by the atomic I with the formation of WI_2. In the developmental lamp shown, the supports operated at a considerably higher temperature than the wall and as a consequence, the iodine did not transfer W from the support to the filament. If this undesirable condition did exist, not only would the supports be attacked and eventually destroyed but excessive W would be deposited on the filament, resulting in whisker growth and the shorting of adjacent filament turns.

Filament Temperature Requiremnts

The minimum filament temperature required for the decomposition of the WI_2 is indicated by an examination of one of the W supports from a developmental lamp, shown in Fig. 4. During normal operation of the lamp, W was deposited on the support near the filament and a certain distance from the filament. The point at which the deposition of

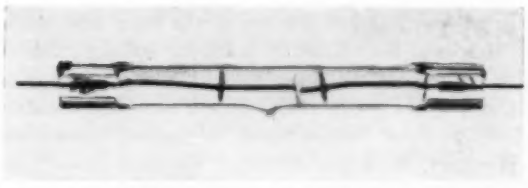


Figure 2. A 500-watt quartz iodine lamp at the end of life—870 hours at 26 lumens per watt.

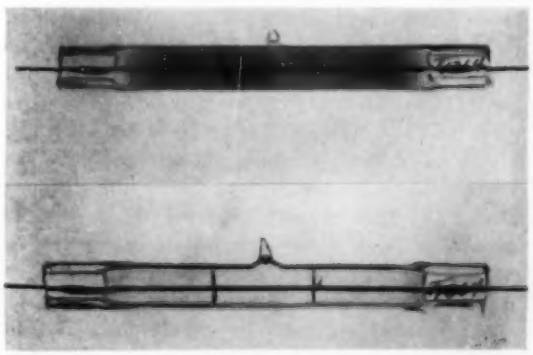


Figure 3. Removal of evaporated W from the bulb wall by iodine cycle. Lamp at top—blackened under vacuum prior to filling; at bottom—same lamp after 60 seconds of normal operation.

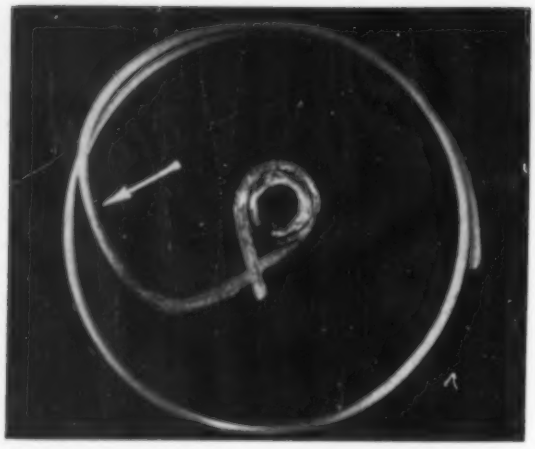


Figure 4. Deposition of W on a support by iodine cycle. Arrow indicates point at which deposition ceased.

W ceased, indicated by the arrow in Fig. 4, was determined by microscopic examination. The temperature of this point on the support was determined in several identical lamps with an optical pyrometer. The average temperature obtained, assumed to be equivalent to the minimum filament temperature required, was well below 2000C, which was substantially below the normal operating temperature of incandescent lamp filaments. However, if the I_2 cycle were to be used in discharge lamps to return evaporated or sputtered metal to the electrodes, this temperature limit could be of very considerable importance.

Iodine Concentration

A priori, the I_2 concentration should be minimized due to the strong absorption of visible radiation by the I_2. Aside from this consideration, there appeared to be no upper limit for the successful operation of the cycle. The lower limit was difficult to establish due to the presence of varying trace quantities of metallic impurities in the developmental lamps which formed stable iodides in the cooler sections (corners) of the lamp, resulting in a depletion of the I_2 concentration. The concentration of I_2 studied was in the range 0.01 to 1.0 μ moles/cc. with 0.2-0.3 μ moles/cc. employed in the majority of lamps. This concentration, which imparted a distinct pink color to a lamp when the I_2 was vaporized at slightly elevated temperatures (>50C), was sufficiently low so that there was no measurable loss of visible radiation by adsorption and sufficiently high so that the usual trace quantities of impurities encountered did not appreciably deplete the I_2 concentration by the formation of stable iodides.

Inert Gas

While evaporated W could be returned to the filament by the I_2 cycle in a vacuum lamp, an inert gas such as Ar, Kr or Xe (600-6000 mm.) was employed in the developmental lamps to prevent arcing and also to decrease the rate of evaporation of W. It was found that if the rate of return of W to the filament were large, whisker formation, pronounced crystal growth on the filament surface and preferential deposition of W on the cooler areas of the filament in the vicinity of the supports and leads was observed. Consequently, it was desirable to minimize the rate of transfer of W to obtain maximum life. While most of the developmental lamps were filled with 600 mm of Ar, there was a tendency for the lamps to arc at the end of life. Due to the high current surge during the arc, the Mo foil in the pinch seal frequently ruptured and the lamp exploded. This situation was rectified either by an external fuse or by increasing the Ar pressure. With an increase in Ar pressure, there was also a considerable increase in life at the same efficiency. These small diameter tubular lamps operate inside the so-called Langmuir sheath[2] where heat loss is due solely to conduction and is independent of pressure in this range. Consequently, an increase in inert gas pressure resulted in an increase in life by decreasing the rate of evaporation of W from the filament while the wattage, filament temperature and efficiency remained constant.

The I_2 cycle can also operate under certain conditions in the presence of N_2 which is important in certain lamp construction where close spacings present arcing problems. No evidence has been found for compound formation between the N_2 and I_2 (or I), *e.g.*, NI_3, during operation of these developmental lamps.

Difficulties

(1) In small diameter tubular lamps (6-12 mm o.d.) of the 500-watt variety, a thermal diffusion separation[3] of the I_2 and inert gas occurred when the lamp was operated vertically or even several degrees off a horizontal position, resulting in the heavier gas, *i.e.*, the I_2 being concentrated at the bottom of the lamp and the lighter inert gas at the top. This thermal diffusion separation depleted the I_2 concentration at the top of the lamp and blackening resulted. In small diameter 500-watt lamps, the separation which, in general, was a function of temperature gradient and length was unfortunately efficient and necessitated horizontal operation. However, in larger diameter 500-watt lamps (20-35 mm o.d.) turbulent convection currents were operative and promoted remixing so that the sep-

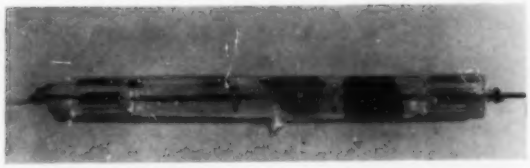


Figure 5. Blackening due to small quantities of impurities in horizontally-operated lamp.

aration did not occur and the lamps could be operated in any position.

(2) It has been found that small quantities of certain materials, *e.g.*, Al, Ni and Hg, interfered with the successful operation of the I_2 cycle and blackening resulted even in the presence of sufficient I_2. This blackening, shown in Fig. 5, occurred on specific areas of the bulb wall. While blackening of this type usually occurred early in life with no apparent effect on life, it has been observed to occur at any time during life. While the exact cause of this type of blackening has not been established, it is believed to be the result of an accumulation of impurities and a specific surface condition of the bulb wall in certain areas.

(3) Due to the highly reactive nature of the I_2 vapor at elevated temperatures, it was not possible to employ any of the usual getters in the developmental lamps to remove H_2O vapor or H_2 present initially or released from the quartz during operation. Either the I_2 and the getter reacted to form a stable iodide in the cooler areas of the lamp, resulting in a depletion of the I_2 and subsequent blackening, or else the getter material interfered with the formation of WI_2 on the bulb wall, resulting in blackening in the presence of sufficient I_2. While the I_2 cycle operated successfully in the presence of the H_2O cycle,[1] resulting in a clean lamp throughout life, the life of the lamp was considerably shortened due to H_2O cycle activity. Consequently, it was necessary to minimize the H_2O cycle activity by a good bake-out of the lamp prior to filling and then employing thoroughly dried I_2 and inert gas to insure long life.

Design Features

Lamps made to operate with the iodine cycle have not only shown an extremely high lumen maintenance, but also have other outstanding features which are direct results of meeting the essential requirements for successful operation. As previously indicated, a minimum bulb wall temperature of about 250C is required for reliable performance. This fact dicated the use of either Pyrex, quartz or Vycor as a bulb and lamps were made to operate successfully in each of these materials. All lamps discussed in this paper were made from tubular quartz or Vycor because of their higher melting points and very good resistance to thermal shock. If a bulb wall temperature of approximately 250C or greater is to be maintained, the filament must be located comparatively close to the bulb wall. A tubular bulb allows us to achieve this temperature without large variations between temperatures at the hottest and coolest portion of the bulb on which the cycle is functioning. The tubular construction also shows other advantages when the lamp is mounted in a luminaire.[5]

Interference with the iodine cycle caused by metals other than tungsten necessitated making lamps without filament supports or with supports of tungsten, and also indicated that the portion of the lead projecting into the lamp must be tungsten. The basic construction of an iodine lamp is shown in Fig. 1. The leads are two piece molybdenum-tungsten and the supports are tungsten wire. This design meets the temperature and material requirements and also permits an increase in operating voltages because of the double-ended construction. By increasing the length of the coil, a 10,500-watt argon-filled iodine lamp which successfully operates on 2400 volts has been made.

Fig. 6 shows some of the developmental lighting lamps that have been made in which the iodine cycle functions properly. From top to bottom, these lamps are rated at 45-, 100-, 150-, 200-, 500- and 1500-watts. They range in length from $1\frac{5}{8}$ to 10 inches, and from $\frac{5}{16}$ to $\frac{1}{2}$ an inch in diameter. Operating voltage for the group is 120 volts or less, with the exception of the 1500-watt lamp which operates at 277 volts. One obvious advantage of this

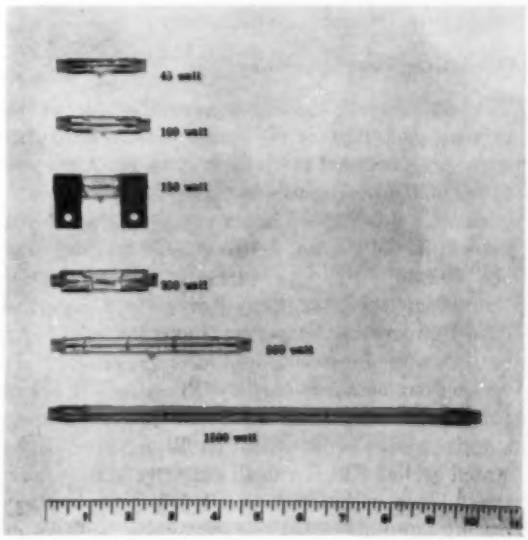


Figure 6. Developmental quartz iodine lamps.

Figure 7. Size comparison of quartz iodine lamps with standard lamps of equal or near-equal wattage.

Figure 8. 500-watt standard lamp and 500-watt quartz iodine lamp after failure.

design is the size reduction it has achieved. In Fig. 7, a comparison of the size of the 45- and 1500-watt iodine lamps is made with that of standard 40- and 1500-watt lamps. The volume of the 45-watt lamp is 1.4 per cent of that of the 40-watt A19 and the 1500-watt volume is .55 per cent of that of the PS52 lamp. The remarkable size reduction is further evidenced by the fact that all of the lamps shown in Fig. 6, which represent a combined total of 2495 watts, occupy less volume than a 25-watt household lamp. Smaller size also means better positioning of the light source in a reflector or luminaire, enabling us to obtain beam patterns heretofore unobtainable.[5]

Operating Characteristics

A unique and favorable characteristic of the tubular lamp is that its lumen output and watts for a given filament are independent of fill gas pressure from a few hundred millimeters to as high a pressure as the bulb will contain. As is commonly known, in the general lighting lamp thermal losses are due to convection currents and conduction. Convection currents passing over the filament reduce its operating temperature and lower its lumen output, while increasing its watts. The effect of convection currents is changed with changes in fill gas pressure, thus, initial lumen and watts rating in a standard lamp is dependent on fill pressure. It was stated earlier that the small diameter bulb contains the fill gas within the so-called Langmuir sheath during lamp operation and convection currents are non-existent. Thermal losses are then due only to conduction and these losses are independent of gas pressure above a few hundred millimeters. Another favorable result of placing the filament in a small diameter bulb is that of obtaining a higher operating pressure than is obtained in the standard lamp for the same fill pressure. A standard 1000-hour, 500-watt, 19.8-lumen per watt lamp is filled with 600 millimeters of gas and operates at approximately 800 millimeters. The 500-watt filament, when placed in an iodine lamp of the tubular design which is filled with 600 millimeters of gas, will operate at approximately 1800 millimeters. An increase in operating pressure, plus the complete absence of convection currents, enables us to increase the efficacy of the filament to 21 lumens per watt and obtain a 2000-hour life. One more example of gain in efficiency is shown in the comparison of a 1500-watt, 275-volt lamp and a 1500-watt, 277-volt iodine lamp. The standard lamp operates at 17.5 lumens per watt for 1000 hours, while the iodine lamp operates at 22 lumens per watt for 2000 hours.

Lumen maintenance, by far the outstanding feature of this lamp, has ranged from 96-101 per cent on constant voltage lamps at 99 per cent life. These figures are quite remarkable when compared with those of the 500-watt general lighting lamp, whose lumen maintenance is 86 per cent at 70 per cent design life, and the 1500-watt lamp, whose lumen maintenance is 78 per cent at 70 per cent design life. Although figures are not available, it can be seen that the comparison would be even more astounding if the standard lamps were rated at 99 per cent design life. Fig. 8 shows a 500-watt stand-

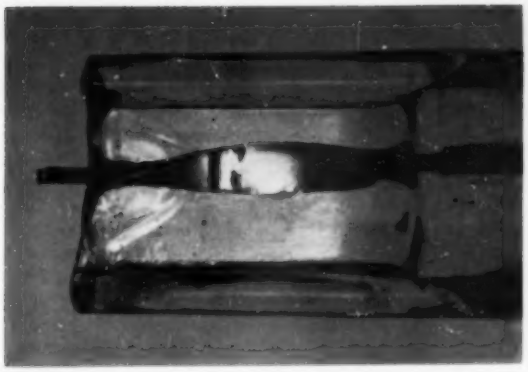


Figure 9. Typical failure pattern on overheated seals. Seal has not yet failed.

ard lamp and a 500-watt iodine lamp after burnout. The percentage of lumen maintenance quoted for the iodine lamp has been measured on all constant voltage lamps, regardless of wattage.

The iodine lamp as designed, in comparison with a presently-made incandescent lamp of equal wattage, offers an incandescent light source that is drastically reduced in size, with ratings independent of fill gas pressure. Its total lumen output can be increased while maintaining equal life, it can be operated at higher voltages and it maintains 96-101 per cent lumen output until burnout.

Operating Limitations

As is true in other lamps, precautions must be taken with the iodine lamp if it is to give the expected service. We have said that wall temperatures below approximately 250C were too low for reliable cycle operation; therefore, these lamps cannot be operated in a cooling atmosphere. Operation under water or in stiff drafts without a protective covering is not feasible. However, the lamps do perform satisfactorily under normal conditions and applications since the wall temperatures are high enough (500-600C) to maintain adequately the specified minimum. One other temperature limit which it has been necessary to specify is that of the seal. This limitation applies to the developmental lamp construction and is not necessarily a feature of all iodine lamps. Fig. 9 shows the type of failure occurring with overheated seals. Temperatures in excess of 350C, measured on the quarts directly over the center of the molybdenum foil, are detrimental to lamp life. If operated above this figure, oxidation of the foil is rapid enough to puncture the seal and leakage occurs. Lamps placed in evacuated chambers or chambers containing a non-oxygen gas have only the current carrying capacity of the foil as a limitation.

Gas separation, which has been fully explained, was found to be quite pronounced in the longer lamps. The 500-watt and the 1500-watt lamps must not be positioned more than four degrees from a horizontal plane if sufficient iodine is to remain in the high end of the lamp for efficient cycle operation. In the lower wattage lamps the gas separation is not so apparent and these lamps have been operated successfully in a vertical position.

The last precaution that we must indicate is one that is no new, nor limited to the iodine lamp. A fact that many of us may not be aware of is that all high-wattage, argon-filled incandescent lamps are internally fused to protect them against arcing. The common cause of arcing is the failure of the filament at or near the peak of inrush current when the lamp is energized. If not arrested, the arc may cause rupture of the bulb. As presently made, the iodine lamps do not contain an internal fuse and therefore the high-wattage lamps must be externally fused to protect against this type of failure.

Applications

A discussion of the iodine lamp would not be complete without mention of possible or actual applications. It should be noted, however, that these lamps are in a developmental stage and are not presently mass produced. A broad answer to the question of what applications are the lamps suited for is that they can be used in any application that now uses incandescent lamps so long as the required conditions of temperature and position are met. Some specific possible applications would be street lighting, floodlighting of outdoor areas, display window lighting, and illumination for movie making and television. Miniaturization is a prime factor in these applications. To date, four types of iodine lamps are being used in actual applications; only one type has developed to the point of supplying lamps in small quantities. The 45- and 209-watt lamps are being tested for possible use in runway illumination and the 1500-watt lamp is being used to successfully grow algae in underwater and space travel research. The 150-watt lamp has been flight tested and is being used as a wing tip marker on high speed aircraft. While there are many possible applications, the ones mentioned are those in which this lamp may find initial usage; small size and nearly constant lumen output are features which we feel certain will guide it into numerous others.

Acknowledgement

The authors wish to acknowledge their indebtedness to A. Foote, Large Lamp Department, for his guidance and assistance during this work.

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DISCUSSION

W. G. MATHESON:* The work reported in this paper deals with results obtained using tubular envelopes. Should one assume that no work has been done on globular envelopes or that the results obtained were unsatisfactory? The necessity of external fusing is not desirable. Also, the precise positioning with respect to the horizontal involves new fixture designs. In fact, it is likely to require extensive fixture replacement with a new design in order to accommodate the proper fuse protection and a satisfactory light distribution pattern.

The authors have indicated a high degree of success in controlling the redeposition of the evaporated tungsten on the filament. We have made tests which indicate that this control is critical due to bulb and filament temperature variations.

A. W. WEEKS:** I would anticipate considerable difficulty in controlling the exacting manufacturing processes required, but undoubtedly these can be met. The following questions have occurred to me:

Is it possible to "coil up" the longer tubular lamps, such as the 1500 watt, so that spotlighting applications would be furthered?

Under the paragraph "Application," the authors say that requirements of temperature and positioning must be met. They then say that the 150-watt lamp has been flight-tested as a wing tip marker. This application does not seem to meet requirements of temperature and positioning.

G. A. FREEMAN:† The accomplishment of a practical lamp with 100 per cent lumen maintenance, as described in this paper, is indeed a milestone of lamp improvement. The function of the reaction between halogen gases, iodine, chlorine, etc., with tungsten to remove tungsten blackening from a lamp bulb is not new, but to control it for practical use *is* new.

This is interesting particularly to lamp development engineers who have experimented with iodine or chlorine in the gas filling of incandescent lamps and then set it aside after finding out the requirements for successful operation. The authors have been quite conscientious in pointing out the problems.

Most experimenters have considered the more conventional forms of incandescent lamps where ordinary lamp leads are chemically attacked by the iodine vapor and the minimum temperature requirement of 250C-300C is difficult to achieve. Potential gain in intrinsic quality was not enough incentive to overcome practical limitations.

The tubular quartz lamp with only tungsten parts appears to meet the requirements with fewer practical limitations. Whether the gain in intrinsic quality comes at too high a penalty in light source shape, in limited operating position and in production cost and dependability where trace quantities of impurities would be ruinous remains to be seen. The authors are to be commended on their development which appears to have attained the necessary degree of practicality.

E. G. ZUBLER AND F. A. MOSBY:* In reply to Mr. Matheson we have found that the iodine cycle does not function satisfactorily in globular envelopes such as the standard "A" bulb shape. There are two reasons for this. First, temperature variations are such that the cycle does not operate on all portions of the bulb, and second, manufacturing methods for the usual "A"-shaped lamp do not permit all tungsten parts internally. Also, the fact that a minimum wall temperature of 250C is required would prohibit its use in present standard sockets.

In answer to Mr. Weeks' question, there has been no attempt to coil up the 1500-watt lamp since a shorter lamp could be obtained by using a coiled-coil filament. The 500- and 1500-watt lamps are not now offered with coiled-coil filaments because of support problems.

As stated in the paper, the lower wattage lamps are not restricted to a horizontal burning position and the 150-watt lamp falls in this group. Temperature specifications for the wing tip application are above the 350C seal limit. However, the aircraft manufacturer and his customers are fully aware of the seal limitation and still choose to use the iodine lamp because they have found no other which will perform as well.

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Annual Index to IE

The Index to 1959, to be published as Section II of the January 1960 issue of ILLUMINATING ENGINEERING, includes subject and author indexes and, in addition, business addresses, where available, for IES officers and committee personnel for 1957-1958 and 1958-1959.

Applications of the Quartz Lighting Lamp

By CARL J. ALLEN
RONALD L. PAUGH

A newly developed line of filament lamps in quartz tubular envelopes employs an "iodine cycle" to eliminate tungsten darkening. Lamps of these characteristics provide several features having unique application advantages. These features are: (1) high wattage in small volume bulbs, (2) good luminous efficacy with practically no reduction in light output throughout life, (3) efficient operation on high-volt as well as on standard 120-volt circuits, (4) increased life without the usual accompanying reduction in filament temperature and efficacy.

Among the lamp's potential applications are its use for certain high-voltage general lighting applications and for special applications where its small size and optical control features are the determining design factor.

THE QUARTZ lighting lamp[1] bids well to be revolutionary in its effect on certain phases of lighting practice. It offers unusual physical and functional features which permit the design of reflectors and luminaires never before practicable with a general purpose light source. These features not only give it advantages in specialized optical applications but also give it cost-of-light advantages for certain of the general lighting application fields.

Characteristics That Affect Applications

The characteristics of this new filament lamp are: (1) high wattage in small volume bulbs, (2) good luminous efficacy with practically no reduction in light output throughout life, (3) efficient operation on high-volt as well as on standard 120-volt circuits (4) increased life without the usual accompanying reduction in filament temperature and efficacy.[1] As an example, a developmental 1500-watt, 277-volt lamp in a $\frac{3}{8}$-inch diameter quartz tube has an initial efficacy of 22 lumens per watt with a 99 per cent mean output over a life of 2000 hours. Thus this new T-3 quartz lighting lamp shows about a 65 per cent gain in mean lumens over the same wattage in a PS-52 bulb designed for 250 volts and 2000 hours' life.

When the cost advantages of the lamp's high mean luminous efficacy is combined with the definite savings of the higher voltage lighting circuits and the possible savings of potentially lighter-weight, higher-efficiency luminaires, the quartz lighting lamp becomes a potential contender for many lighting applications.

Previously the operation of filament lamps at higher than 120 volts with former lamp designs resulted in lowered luminous efficacy and reduced filament ruggedness. This ability of the quartz lighting lamp to operate efficiently on the higher circuit voltages will be of specific value in industrial lighting and other areas where the 277-480 voltage systems are used.

The lamp's small bulb diameter (see Fig. 1) together with its accurately located filament makes possible the use of small size reflectors possessing a

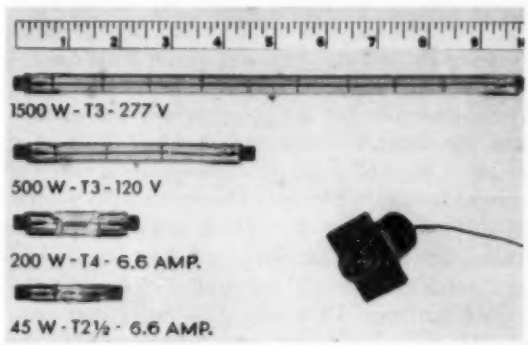

Figure 1. Examples of quartz lighting lamps with a sample of a developmental lampholder.

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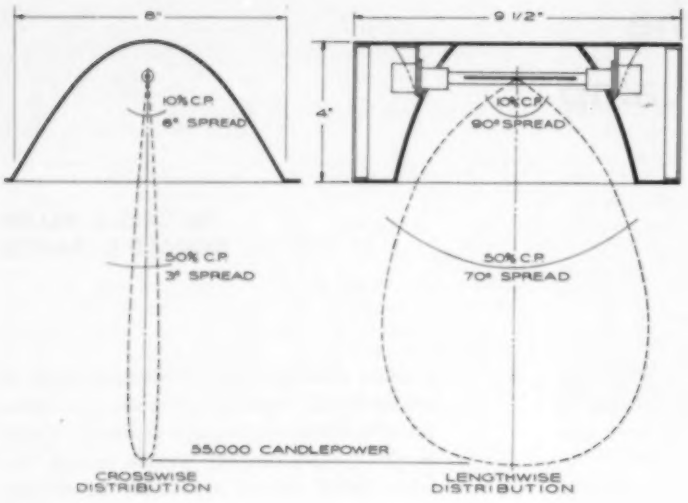


Figure 2. Developmental parabolic trough reflector with parabolic end plates.

high degree of optical control. For example, the 500-watt developmental parabolic trough reflector shown in Fig. 2 can produce a fan-shaped beam of light only six degrees across its narrowest dimension. Such excellent control is possible in the plane which is perpendicular to the axis of the lamp. In the plane of the lamp the beam will have a broad distribution due to the extended length of the filament. In many applications such a distribution of light, narrow in one plane and broad in another plane, is very desirable. Lighting for building fronts, sport fields, airport runways and show windows are a few examples where such a beam shape has advantages.

The quartz lighting lamp has a few limitations which must be considered in designing and applying equipment. For example, the lamp must be operated within about 4 degrees of horizontal in order that the iodine will not separate out to the low end of the lamp. In addition, the molybdenum lead-in wire must be kept below 350C where it enters the pinch seal of the lamp. Above this temperature the molybdenum wire oxidizes rapidly, thus increasing in size, and acts as a wedge to break the seal. The bulb wall temperature must be kept above 250C, otherwise the iodine cycle will not operate and the lamp will darken. Another limitation, which is more of a safety requirement, is that the present lamps must be individually fused to protect against lamp rupturing due to arcing at end of life. This is not a new condition as it is common practice to internally fuse all argon-filled lamps of the higher wattages. Care should be taken that combustible materials do not come in contact with the lamp as the 500-600C bulb wall temperature is above the kindling point of many common items. On the other hand it should be noted that, at this temperature, atmospheric dust and dirt will tend to incinerate off the lamp's surface and hence minimize the light-absorbing film of the usual dirt deposits on lamp bulbs.

Lampholders

The requirements for a lampholder are that it should (1) help keep the lead-in wire temperature below 350C, (2) provide accurate positioning of the lamp, and (3) conform to safety concepts. The developmental lampholder shown in Fig. 1 was designed to fulfill these requirements. It is of the push-pull variety. Preliminary tests on pilot models of this lampholder indicated that the lead-in wire of the lamp could be kept below 275C in a mock-up of an enclosed outdoor floodlight equipped with a 500-watt T-3 quartz lighting lamp. In a developmental model of an industrial type reflector designed for the 1500-watt T-3 lamp it was found necessary to ventilate the top of the reflector to lower the lamp's lead-in wire temperature. It is obvious from the concentrated thermal nature of this lamp that temperature conditions will be an essential consideration in the design of equipment for its use.

Reflectors

The small diameter filament accurately located in relation to the bases permits rather precise optical control in trough type reflectors. The extended length of the filament in the axial direction makes it difficult to control the endwise distribution of light from the lamp. However, by the use of special parabolic end plates in a trough reflector for the 500-watt T-3 as shown in Fig. 2 the endwise

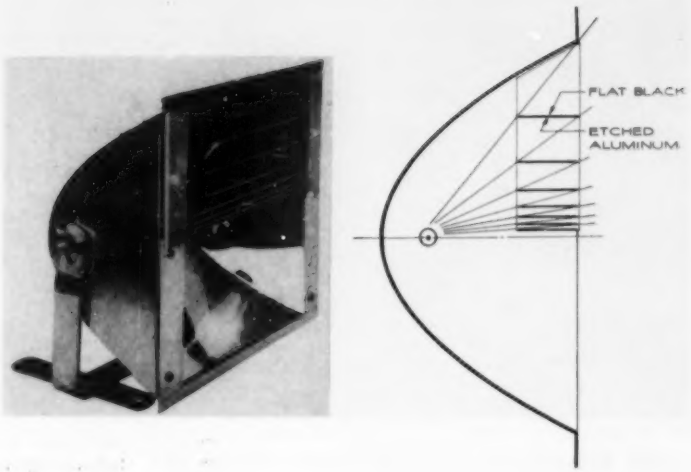
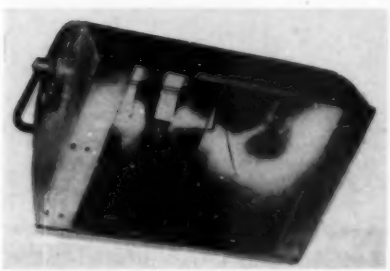


Figure 3. Parabolic reflector for 500-watt T-3 quartz lighting lamp with louver for upper part of beam.

light can be redirected back into the beam with considerable advantage. Thus such a reflector and lamp combination provides a narrow fan of light with sharp cut-offs.

In many applications of parabolic reflectors it is desirable to shield the lamp and the direct light to reduce the glare in one direction as much as possible. This can be done by using louvers over one half of the reflector opening (see Fig. 3). The sides of the louvers opposite the lamp are finished in dull black to reduce brightness. The other sides are high-reflectance etched aluminum to minimize the loss of useful light. This half-louvered floodlight would be useful in lighting building fronts when the units are located anywhere from ground to eye level. In such an installation the stray light is kept out of the eyes of passersby and in addition the light reflected from the etched side of the louver illuminates the lower building surface. Such a louvered fixture would also be useful in lighting a building front from above, where glare light to the street is to be minimized. The same method of louvering may have possibilities in the lighting of airport runway touch-down areas. The louvers in this case would keep glare brightness out of the pilot's eyes. For indoor applications the same louvered reflector would be equally useful in vertical wall lighting. Slight variations of the narrow beam louvered unit would also be useful in lighting museum picture walls.

By using an elliptical contour for the reflector and by also using parabolic end sections, a rectangular beam luminaire can be obtained. As the 1500-watt lamp has industrial lighting possibilities the reflector shown in Fig. 4 was developed using this principle. Since essentially all the light reflected by the luminaire is reflected down within the 45-degree shielding zone there is a minimum of direct glare from such a fixture. The slots above the lamp provide uplight and also ventilate the fixture, permitting the ends of the lamp to operate at a satisfactory temperature.



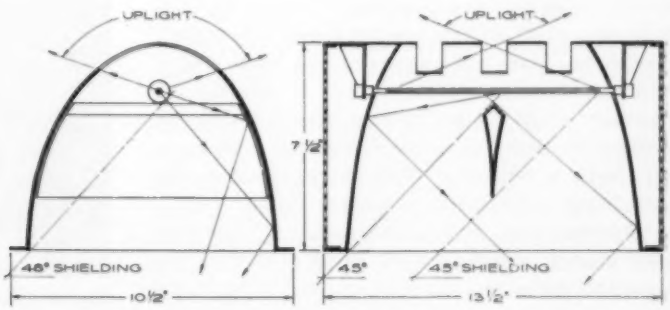


Figure 4. Developmental direct lighting fixture with up-light component for 1500-watt T-3 quartz lighting lamp. Shielding is 45 degrees.

Figure 5. Developmental runway lighting system using a 200-watt T-4 6.6-ampere quartz lighting lamp in a fixture as shown in insert.

The following is a brief description of some of the first special applications and a discussion of potential general lighting uses of the quartz lighting lamps.

Special Applications

The first application of a quartz lighting lamp[2] was in connection with wing tip lighting on jet airplanes. Here the requirement was for maximum light in minimum space and a 150-watt, T-4, 28-volt lamp was developed for this service. Three unusual lighting installations are currently under test using quartz lighting lamps. These involve (1) airport runway floodlighting, (2) airport runway-taxiway marker light and (3) an oxygen regenerative cell.

Airport Runway Floodlighting

The Federal Aviation Agency Technical Development Center is currently developing an incandescent airport runway floodlighting system. Such a system is to floodlight the runway without introducing excessive glare in the eyes of the landing pilots. A tentative specification for the fixture is that it is to be mounted at the runway edge and approximately 30 inches above the runway. The design is to be such as to limit the vertical beam spread of the unit to a maximum of 4 degrees. The only lamp small enough to allow the precise control needed to obtain a 4-degree vertical beam spread and yet of high enough wattage to provide the necessary beam lumens was the 200-watt, T-4, 6.6 ampere series-operated quartz lighting lamp. In this lamp a coiled-coil filament construction was used to reduce the filament's axial length.

Developmental fixtures consisting of accurate glass mirror reflectors and spread lens were designed to utilize this 200-watt quartz lighting lamp and to meet the above mentioned photometric requirements. These were mounted on 20-foot centers along each side of the test runway at Seymour, Ind., for a distance of approximately 200 feet. The runway is 125 feet wide and the units are mounted opposite each other 25 feet back of the runway edge. Fig. 5 is an actual night photograph of the floodlighted runway showing that the area of highest illumination is in, or near, the center of the runway, where it is most useful to the pilots. Fig. 5 also shows the surface brightness across the runway.

Airport Runway-Taxiway Marker Lights

A new semi-flush unit known as the "pancake" marker light shown in Fig. 6 has recently been designed[3] to guide the pilots while they are landing and moving their ships on the runways and taxiways at night and at times of low visibility. A major advantage of this thin 6-inch diameter fixture is its easy adaptability to existing runways, high speed turnoffs and taxiways with only minor

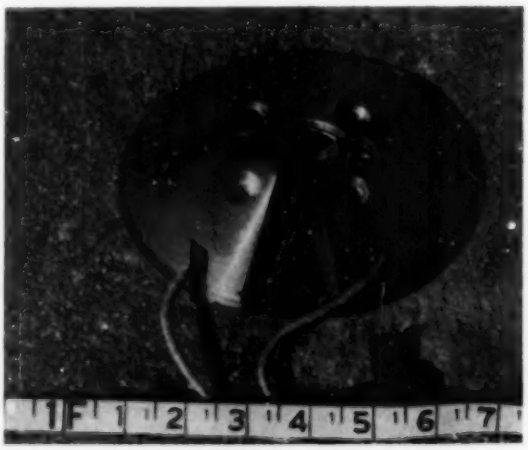


Figure 6. A prototype runway marker light developed by the Federal Aviation Agency. The 45-watt T-2½ quartz lighting lamp is used in this fixture.

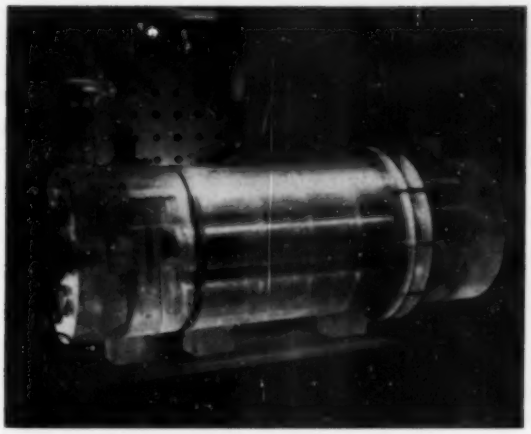


Figure 7. A photosynthesis gas exchanger of about one cubic foot size which theoretically can provide the oxygen requirements of one or two men in a space ship. Quartz lighting lamps are used since their light energy density for equal volume is one thousand times better than that of mercury lamps and three thousand times better than that of fluorescent lamps.

cutting of the runway surface required for installation. This fixture is radically new in its design in that the light source will be housed in the ¾ of an inch the fixture projects above the surface of the runway. The small size of the 45-watt quartz lighting lamp (T-2½—2-inch-long) is a major contributing factor to this unit's feasibility for this service.

Oxygen Regenerative Cell

Recent advances in naval and space travel technology have provided means of cruising under the oceans for long periods and have given the hope of some day exploring the vastness lying beyond our atmosphere. This technology has allowed our machines to approach these goals quite readily but man's adaptability is more limited. Man must carry along or create his atmosphere and food in order to survive. A means of regenerating his atmosphere and growing his food seems more feasible than carrying food with him. One method being investigated[4] is to actually carry in each submarine or space ship a small portion of mother nature's life-sustainining phenomena—that of photosynthesis. With space a premium on each type of vehicle, a compact photosynthesis system utilizing the most efficient and compact plant life and equipment must be used. In preliminary investigations six 1500-watt T-3 quartz lighting lamps were used as the artificial "sun" with a newly developed high reproductive strain of algae in the equipment shown in Fig. 7. The quartz lighting lamp was chosen because of its small size, high output and desirable spectral qualities. This combination plus new methodology has reduced the volume of algae required to sustain man to one-twentieth of that formerly considered necessary. Thus this new lamp in combination with oxygen regenerative equipment may enable man to travel in outer space or beneath the sea for indefinite periods of time.

Industrial Lighting

It is difficult to predict at this time whether the quartz lighting lamp will be more widely used in spectacular applications like the above or in the general lighting of large area installations such as in industry. There is considerable evidence for the latter.

Exploratory cost analysis indicates an initial cost for a 1500-watt quartz lighting lamp industrial installation which would be substantially lower than any other common system. This is primarily the results of the lamp's high sustained luminous efficacy, its ability to operate effectively on 277 volts and an assumption that a luminaire for its use would be rather high in utilization and moderately low in cost. While the lamp's operating cost is higher than fluorescent or mercury systems, the initial cost in some cases can be more the deciding factor than operating cost. This is especially true when hours of use are not extensive and power rates are low. Because of the small size of the lamp, good shielding and brightness control are relatively easy to attain with high fixture efficiency.

A possible application for the quartz lighting lamp is on traveling cranes where the available voltages are commonly in the higher voltage ranges. Testing is now in process to determine whether the quartz lighting lamp can stand the rigor of this type of service.

Store Lighting

In the store lighting field the quartz lighting lamp will bring about a new line of lighting tools for the merchant and store designer. Its unusual ability to be used in highly accurate light controlling reflectors of simple design will find wide applications in such fields as show window lighting, counter lighting, vertical display lighting and other applications where a controlled band of light is desired.

For general lighting the lamp's small size will allow the fixture designer to create wafer-thin lighting fixtures of shapes and sizes not previously possible. For example, three 500-watt T-3 lamps arranged in a triangular pattern could easily fit in a flat dish-shaped indirect luminaire only 1 inch deep by 11 inches in diameter. Three 1500-watt lamps could fit in a shalliow circular fixture 1 inch deep by 15 inches in diameter. This possibility

opens up new avenues in incandescent luminaire styling.

Building Floodlighting

When the broad front of a building is to be floodlighted the narrow beam of the T-3 parabolic reflector can be advantageously used. As the beam of this unit is narrower than usually found in general floodlights, it can be located closer to the building with greater effectiveness. When floodlighting from above, as narrow a beam as possible is usually the requirement because of the necessity of restricting the overhang of the equipment out from the building. The half louver developed for the T-3 parabolic reflector, Fig. 3, is specifically useful when lighting building fronts and sidewalks from the tops of buildings to minimize undesired fixture brightness. Such a luminaire is also desirable because of its small size and low wind resistance. Due to the narrowness of the beam, more of the beam lumens can be delivered to the building with an increase in the utilization of the floodlighting and reduction of over-all cost.

Bulletin and Poster Lighting

As the poster panels and bulletin boards are rectangular areas they are well suited to the elongated beam shape of a T-3 lamp in a trough reflector. Such reflectors could be designed to be lighter and smaller and with their better control possibilities they could offer higher utilization of light than typical reflectors now used. More accurate control could also result in closer mounting with less spill of light on the surrounding area.

Sports Arenas

The lighting of a sports arena is one area where the initial cost of a lighting system can be more of a determining factor than is its operating cost. The hours that a sports arena is occupied by paid attendance with the full lighting system on can frequently be of the order of twenty or so hours per week. Under such conditions the initial cost is then the major part of the total owning and operating cost. A 1500-watt quartz lighting lamp fixture has the advantages of the economy of 277-480 volt distribution, potentially low-cost fixture design and better than normal incandescent maintained efficiency. In addition such fixtures offer excellent visual comfort for the spectators because of the potential good shielding. The unusual low weight of the fixture also suggests low-cost catenary installation possibilities.

Golf Driving Ranges

The lighting of a golf driving range is an excellent example as to where a 6- x 90-degree beam parabolic trough reflector can specifically meet the requirements. The problem here is to light a wide expanse of ground extending 100 to 250 yards out from floodlighting poles which generally do not exceed about 25 feet in height. This zone of ground represents about 3 degrees from the top of the poles which is roughly the spread of the 6- x 90-degree beam to 50 per cent of maximum. The horizontal spread to 50 per cent of maximum is about 70 degrees, which again is ideal when lighting such areas which are seldom less than 200 yards in width.

Conclusion

The quartz lighting lamp gives the engineer, designer and user a new, unique and useful light source. Because of its small size and high maintained output it promises to provide better solutions to many of the lighting problems of today and tomorrow.

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DISCUSSION

J. S. Hamel:* When I visited Nela Park last June, Carl Allen and Ron Paugh showed me the new 500-watt and 1500-watt lamps, known as the "Quartz Line" lamp at that time. It was an impressive demonstration of lighting and light control and it was obvious that this lamp had unique characteristics.

We as designers are constantly faced with new developments in both incandescent and fluorescent lamps and this new light source points to some new and unique lighting applications. Certain questions come to mind, however, and I would like to ask the authors what the possibility will be for smaller wattage lamps, say as low as 75 watts, and ranging between 75 watts and 300 watts in 125-volt line voltage. This would be an ideal line of lamps for applications for controlled lighting in a wide variety of commercial interiors, along with applications in stage lighting. Is lamp life adversely affected by dimming this lamp or operating at reduced voltage? Will this affect the iodine cycle enough to cause depreciation of lumen maintenance?

The authors deal largely with use of reflectors for lighting control. Would it not also be possible and very practical to design refracting lens systems for the optical control of light?

*Consulting Engineer, Burbank, Calif.

With regard to the discussion of louvers for lighting control, it has been my experience that louvers become dusty and lose a large degree of their lighting control insofar as reflected light from the louver blade is concerned. Would it not seem more practical to use a prismatic type of lens to accomplish the same kind of control, with a protective cover glass?

Another question comes to my mind since the authors state that the bulb wall temperature must be kept above 250C. Does this exclude the use of this unit in open reflector construction? Is it presumed also that moisture will have no effect on the operating characteristics of this lamp? What is the effect on lumen output of over-voltage application for sports lighting?

In regard to application, there are, of course, many applications beyond those mentioned by the authors. One in particular, however, seems to be important at the moment, in regard to application of this lamp in lighting airport ramp areas. These lamps, built in multiples of reflectors, serve as a linear light source in reflector, embodying the principles of control outlined by Domina Eberle Spencer in her paper last year at the Technical Conference in Toronto (March, 1959 IE, p. 167). This light source in a linear modified parabolic reflector should provide an ideal controlled source of illumination for ramp lighting.

W. F. BLACKFORD:* I concur with the conclusions of the authors that this new light source gives the engineer and the luminaire designer another important tool to use.

In airport lighting applications, the high luminous efficacy and almost 100 per cent lumen maintenance appear to make the lamp a very desirable light source. However, where this type lamp is to be utilized as the light source in a signaling projector, such as high intensity runway or taxiway lighting, it may be necessary to revise the simple and commonly used brightness control methods of varying the voltage and/or current to the lamp in order to maintain the necessary bulb wall temperature for satisfactory operation of the iodine cycle and good lumen maintenance. It should also be kept in mind that this requirement for operation at or near rated wattage may result in a shorter useful life for the 2000-hour quartz lamp than for conventional lamps, which are usually operated at very reduced brightnesses resulting in much longer-than-rated useful lives.

The fixture design principles illustrated in the paper are sound, and if utilized could result in appropriate fixtures for many applications. Since precise optical light control and high lumen maintenance requirement often go hand in hand, this new iodine quartz-type lamp construction may be a very significant contribution to the field of illumination.

WILLIAM WEIBEL:** The authors have done well to prepare this paper at this time. The announcement of the quartz lighting lamps and inspection of the early samples has done much to excite interest in luminaire design for the application of this new source.

It was mentioned that "the lamp must be operated within about four degrees of horizontal in order that the iodine will not separate out to the low end of the lamp." With practical tolerances in the mounting of the lamp in the luminaire and the mounting of the luminaire in operating position, this four degrees seems very restrictive. It is hoped that ways will be found to increase the range within which the lamps will operate satisfactorily.

We understand that "the present lamps must be individually fused to protect against lamp rupturing due to arcing at end of life." Are there plans to internally fuse these lamps?

The operating temperature is reported to be such that "atmospheric dust and dirt will tend to incinerate off the lamp's surface and hence minimize the light-absorbing film of the usual dirt deposits on lamp bulbs." However, we are told that even minute traces of grease, oil or salt from the fingers will cause etching of the bulb surface at the operating temperatures of the lamp. It would seem that temperatures sufficient to incinerate dust and dirt would also easily remove an offending fingerprint. If, indeed, such prints are undesirable, it would seem advisable to ship the lamp in an individual, transparent coating which could be stripped or incinerated after the lamp is in final position in the luminarie.

It is stated that "the bulb wall temperature must be kept aboye 250C, otherwise the iodine cycle will not operate and the lamp will darken." For outdoor use, this will be an important reason why the lamp should be enclosed. Has there been any investigation as to bulb wall temperature in an enclosed luminaire with outside temperature of —29C (—20F)?

Presumably, the maximum allowable temperatures on bulb wall and basing cement will be well beyond those temperatures anticipated in usual application. However, has reflector temperature been investigated under conditions of high ambient temperature operation? Such temperature will, of course, depend on many variables, such as reflector contour, material, finish and position. Surface finishes could very well be adversely affected if such temperatures were excessive.

The spiral-type supports for the filaments of these lamps will no doubt supply the necessary protection. Is there any comparison which can be made between these lamps and expected applications and those for the rough-service or vibration-service lamps?

The authors have answered many questions in the application of these lamps. It is hoped that they will continue their investigations and later bring us additional information as these challenging new lamps gain acceptance.

R. E. FAUCETT:* Floodlighting manufacturers have been plagued for decades with relatively short life, low efficacy incandescent lamps with which to work. This appears to be a significant break-through in the area of not only life and efficacy but also the just as important elements of lumen maintenance and source size.

In the third paragraph the authors state, ". . . possible savings of potentially lighter weight. . . ." At the present time it appears to me that this statement should be limited to those luminaires which require a narrow beam spread in the transverse plane only. If designs of floodlights are contemplated which are to have endwise beam spreads less than 80 degrees, there would be required, in all probability reflectors with longitudinal dimensions far in excess of those presently on the market using general service PS bulbs.

In the fifth paragraph the authors re-emphasize the excellent control of light in the transverse plane. At the same time it should be pointed out that this transverse control is obtained at the sacrifice of less endwise control. This could be an extremely important aspect in some applications. It is true that there would be less spill light in the transverse plane when utilizing these lamps in fixtures of good design. However, care should be exercised to make

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certain that too much light is not lost beyond the sides of the area being lighted. This spill light can also cause objectionable glare under certain circumstances.

The necessity of individual fusing is pointed out as one of the limitations in paragraph six. I would like to pose the question as to when the authors feel that a design will be available which will not necessitate individual fusing.

Paragraph seven points out the importance of designing a fixture to prevent excessive heat from building up around the lamp seals. It would be very beneficial to the fixture designer to know what steps are being taken by the lamp and/or lampholder manufacturers to provide greater heat dissipation so as to minimize this limitation.

A preliminary study has been completed to determine the economic feasibility of utilizing the 1500T3Q/CL lamp for illuminating athletic fields. This study shows that installation of approximately 7 per cent fewer quartz lighting floodlights operating at rated voltage would be required than an installation of 1500-watt general service floodlights operated at 10 per cent above rated voltage to produce the same illumination. The floodlight and lamp cost of this installation may be 20 to 40 per cent more initially than using the 1500-watt PS-52 general service lamps in conventional floodlights. However, this additional cost would undoubtedly be offset by savings in wiring, switching, general distribution and control costs due to having fewer units to wire as well as the use of a higher voltage system. The annual operating cost of the quartz lighting system would be approximately 27 per cent less than the conventional system if operated 200 hours annually. If the systems operate 4000 hours annually, the operation of the quartz lighting system would still be about 18 per cent less to maintain. As the annual hours of operation increase the economic advantage of the 1500-watt quartz lighting lamps decreases, but annual costs still remain below systems employing 1500-watt general service lamps.

C. J. Allen and R. L. Paugh:* In reply to Mr. Hamel, it is anticipated that the iodine-quartz lamp will be available in the future in sizes other than 500 watts for 120-volt service. The 500-watt lamp was the first size developed for 120-volt service because so many applications could be envisioned for its use.

On the matter of dimming, the lamp can be dimmed by reducing voltage as long as there is no unusual cooling effect acting on the lamp, such as might be produced by a cold wind. When the lamp is dimmed in still air by reducing its voltage, the iodine cycle will operate as the bulb wall temperature is lowered from 600C to 250C. When the filament temperature is reduced below the point where the bulb wall is 250C, the lamp operates similar to an infrared lamp. The tungsten evaporation then becomes insignificant and the benefit of the iodine cycle is no longer needed.

The use of refractors to control the light from this compact linear source offers excellent opportunities in fixture design, as Mr. Hamel suggests. Reflectors in the demonstration fixtures were used merely because they were easier to make on a developmental basis.

The 250C bulb wall limitation will probably limit the use of these lamps to enclosed fixtures for outdoor use. One test on a bare 500-watt T3 lamp showed that a 15-mile-per hour wind at 0C would lower the bulb wall temperature to 250C. This test was on a bare lamp and no testing has been done on these lamps in open reflectors under wind conditions.

The operating characteristics for the quartzline lamps are in the process of being determined from life rack data. Thus, it is too early to predict the effects of over voltage on the performance of these lamps. It is expected that the lumens per watt for the quartzline lamp for a given over voltage condition will be slightly better than for a comparable conventional incandescent lamp. This is expected because there are no convection current losses in this lamp.

In reply to Mr. Blackford's question about operation on reduced voltage, the quartzline lamps, like other incandescent lamps, can be reduced in brightness to result in much-longer-than-rated life. If the voltage on a lamp in an enclosed fixture can be reduced, under cold temperature conditions, to 50 per cent voltage without the bulb wall temperature falling below 250C, then no tungsten darkening problem would be expected with dimming throughout the full range of voltage. Also, no darkening problem would be expected if dimming is from 100 per cent to any value below 50 per cent voltage.

The matter of internal fusing, which Mr. Weibel brings up, is being investigated, as it obviously would be desirable to incorporate the fuse in the lamp. Mr. Weibel also asks about the matter of fingerprints on the lamp. Fingerprints will not incinerate off the lamp surface in a manner similar to dust, as fingerprints are caused by body salts which will etch the surface of the quartz. The lamps will come packaged with instructions that the lamp should not be touched with bare hands, or, if touched, they should be cleaned to avoid etching of the quartz bulb.

Mr. Weibel's questions regarding the effect of temperatures on reflector materials emphasizes the point that fixture designers must consider the effects of temperature on the various parts of fixtures. Reflector and refractor materials, gasketing material, electrical conductors and insulation are examples of fixture components which must be tested and evaluated for use with the high temperatures which will be encountered.

The quartzline lamps are not designed to be either rough service or vibration service lamps; however, it is expected that they will be as good as and perhaps even slightly better than conventional lamps in such applications. Testing is in process to determine the degree of ruggedness of this lamp.

Mr. Faucett brings out the point that these lamps are best used to produce elongated beams which are very narrow in one direction. This is true. There are many applications where such a beam pattern is desirable and this is one type of light distribution which can be readily obtained with good efficacy with this lamp.

The problem of extracting heat from the molybdenum lead-in wire to the seal is one the fixture designer, as well as the lamp and lampholder manufacturer, must consider. The lampholder, for example, has been specifically designed to help in this respect. The contact of the lampholder is a rather massive nickel-plated copper bolt which acts as a heat sink to pull heat from the lamp contact. Even the lead-in wire to the lampholder is used to extract heat from the lampholder.

Mr. Faucett's general conclusion that the 1500 T3Q/CL lamps offer real possibilities of significant savings in initial and annual cost as compared to conventional athletic field floodlighting agrees with a similar analysis which we have made.

*Authors

Three-Purpose Lighting Design for

Hotel Roof Garden

NATIONAL ENTRY
CLASS II

Charles E. Strahan, Jr.

Mississippi Chapter

Southeastern Region

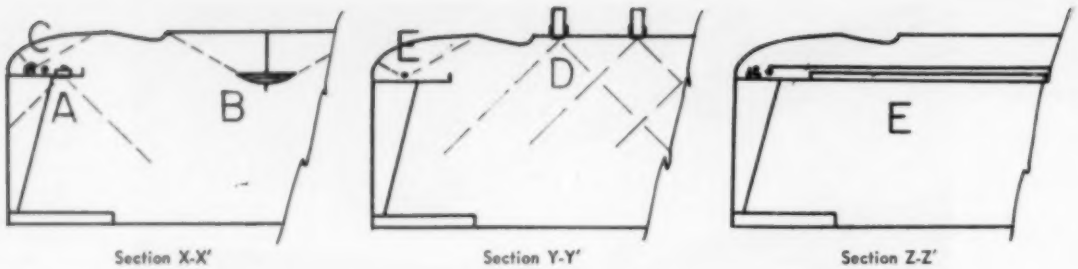
Mr. Strahan is with Mississippi Power & Light Co., Jackson, Miss. This entry was first in the Southeastern Regional MMILJ competition.

PERHAPS sociologists could make a case of the decline of hotel night clubs. Spaces which once came to light only in the small hours now make sense only if they serve this and many other purposes as well.

The Heidelberg Hotel Roof in Jackson, Miss. is a typical example. For years it was a popular spot for dining, dancing and entertainment. Facts had to be faced though, in the realization that the space was no longer profitable unless it could be used for luncheons, convention meetings, social events of various sorts and— a night club dining area as well. This required major remodeling, of course, and especially, flexible lighting designed to serve the multiple purposes.

To over-simplify the situation, the problem was to relight an area 45 feet by 76 feet with a 16-foot ceiling so that:

(a) The mood of the room could be easily changed, by lighting alone, all the way from a cozy night club level of 0.5 or one footcandle of warm soft lighting to a wide-awake "company meeting"



Schematic layout of lighting fixtures for Heidelberg Hotel Roof. A — 11 recessed indirect fixtures with 100-watt S/B lamps. B — 2 custom-built indirect fixtures, each with twelve 300-watt R40 floods. C — 11 striplights with two 8-foot 40-watt T12 rapid-start daylight fluorescents. D — 4 recessed downlights with 45-degree cut-off; 300-watt mogul-base lamps. E — 224 feet of gold neon tubing, operated at 30 ma.

level of 15 to 20 footcandles and at the same time

(b) Enhance the beauty of the decor and

(c) Consider cost.

Color scheme was, of course, all set. Walls, pilasters and cove were dark blue, with a reflection factor of 20 per cent. The curved ceiling area was light blue (49 per cent RF); and flat area along the center of the room a still lighter blue (75 per cent). Drapes and lounge furniture were gold; chairs and table cloths, white.

Incandescent lamps throughout were chosen as the basic lighting source. The question was, their application for these multiple effects. Here is what was done:

Under the cove, recessed indirect fixtures with gold-colored reflectors provide warm attractive light on the tables. (See A in schematic layout). These use 100-watt S/B lamps. Dimmer controlled, they may be lowered to intimate night club levels or raised for dining.

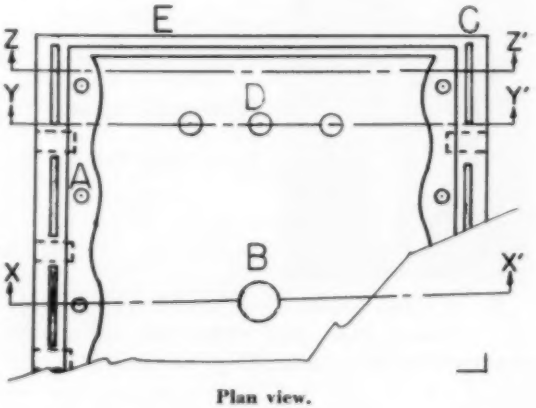
To break the long expanse of the room, two decorative indirect luminaires were specially designed (B in the layout). These are four feet in diameter and each is equipped with 12 300-watt R30 floodlamps which may be adjusted to uniformly fill the flat ceiling area with light. Indirectly, they provide very adequate illumination for the entire main floor area.

One problem was a dark area above the cove and the incandescent light washing out the blue ceiling colors. Light was provided and color added and even reinforced by the 40-watt T12 daylight fluorescent strips (see C on layout) mounted on top of the cove. This is one of the few situations which is tailor-made for the application of daylight fluorescent lamps.

When activities require reduced lighting in the room, speaker tables may be highlighted from the three recessed fixtures in the area, each with 300-watt lamps. (D). These fixtures have a sharp cut-off angle and very low brightness at the ceiling. The entry, incidentally, is also highlighted with one of these fixtures.

All this is for wide-awake activities, but it is quite readily transformed to a blue and gold night club atmosphere with low-level intimate lighting. For this effect, 7½-watt red lamps are used in existing candle fixtures mounted on the pilasters and gold neon tubing, concealed on top of the cove (E), rings the room. This reflects colored light off the ceiling for a gay but intimate atmosphere.

From the lighting alone, all of the multiple purposes of the room may be quickly emphasized. For a night club, warm soft light—only the gold neon and candle fixtures used. Lighting level is 0.5 to one footcandle. For dinner-dancing of a less intimate nature on go the recessed cove lights —tables, eight to ten fc; dance floor, one to two. Going upward, for other uses, general lighting may be turned on or off, up or down. Speakers table may be lighted to 20 to 25 fc with the light pattern so controlled that a projector screen may be used on the wall behind. As to the final consideration—cost was under $2000.



Plan view.

Incandescent Lamp Design Life For Residential Lighting

By WENTWORTH M. POTTER
KIRK M. REID

One of the oldest and most persistent questions raised by engineers and laymen since the invention of the tungsten-filament incandescent lamp is: "How long should an incandescent light bulb last?" This article itemizes and discusses the engineering factors involved in establishing the lamp-design life that gives lowest cost of light to the average residential user. The article also recognizes and discusses certain non-engineering factors, such as the inconvenience of making lamp replacements, that influence the proper choice of design life. The lamp bulbs in question are the familiar "A-line" of general lighting lamps of 15 to 150 watts inclusive, the types most generally used in residential lighting.

The Engineering Factors

The life-efficiency characteristic of tungsten-filament incandescent lamps is well-established.[1-7] It is widely known that when a lamp filament operates at high efficiency, its light output is high in relation to the watts consumed, but its life is short. Conversely, when a filament operates at low efficiency, its light output is low in relation to the watts consumed, and its life is long.

Hence, a design objective of long life, which means best value in most products, does not apply to incandescent lamps. The reason for this difference is that lamp bulbs are not, of themselves, the end-product sought by the user. That end-product is *light*. The lamp bulb is simply a device to transform electric energy into light. To obtain that light, the user pays the costs of facilities for operation and of maintenance, the cost of electric power, and the cost of the bulb itself.

The total of these costs per unit of light flux generated is thus the primary measure of the value of a lamp bulb. Of these costs the price of the bulb itself is only a small part. Yet the amount of light produced in relation to the total lighting cost is determined by the design of the lamp bulb—by its life-efficiency relationship.

The total cost of a unit quantity of light—one million lumen-hours—may be calculated readily by using the cost-of-light equation.[8] The various quantities in this equation have values that depend on and apply to the specific lamp bulb and field of lighting for which the cost-of-light determination is being made—in this case, the residential lighting field. Following is the equation:

Cost-of-Light Equation

$$U = \frac{10}{\bar{Q}\bar{D}}\left(\frac{P+h}{L} + \bar{W}R + \frac{F+M}{H}\right)$$

where:

U = Unit cost of light ($ per million lumen-hours);
$\bar{Q}$ = Mean lumens, corresponding to L;
$\bar{D}$ = Average maintenance factor due to dirt accumulation on lamp bulb and/or luminaire parts, corresponding to $\bar{Q}$ and L;
P = Market price of lamp, in cents;
h = Labor cost of lamp replacement, in cents;
L = Average life, in thousands of hours;
$\bar{W}$ = Mean watts;
R = Energy rate, in cents per kwh;
F = Fixed charges per socket per year, in cents;
M = Cleaning cost per socket per year, in cents;
H = Hours of operation per year, in thousands.

In the above equation, lamp life is assumed to be changed by a redesign of the filament, with lamp wattage held constant and with rated lamp voltage and socket voltage constant. In contrast, when lamp life is changed by varying either the socket or the lamp voltage, the lamp wattage also changes.

Using the equation, the unit cost of light may be determined for a variety of lamp lives in each lamp wattage. The lowest cost will then indicate the most economical design life. Examples of such calculated unit costs, applying for three design lives of the 100-watt general service lamp with CC-8 filament, are presented in Fig. A-1, Appendix A.

For this article, the values used in the cost-of-light equation are, of course, those that apply to residential lighting. Some of the values, notably average cost of electrical energy, lamp cost, and lamp lumens, can be determined fairly accurately from authoritative sources. Others, such as wiring and fixture costs, hours of lamp operation per year,

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and handling costs for replacing lamps and cleaning fixtures, must be estimated with good judgment from available information. Following are the values, with comments:

Mean Lamp Lumens ($\bar{Q}$)—Values of mean lamp lumens, for lamps of lives currently listed, are test results. These test results are also the basis for determination of mean lumens for lamps of other lives. Appendix A presents a typical series of values of mean lumens for lamps, in each case consuming 100 watts initially, with several design lives.

Average Maintenance Factor ($\bar{D}$)—Depreciation in light output due to dirt accumulation on the lamp bulb and the luminaire parts, averaged over the lamp life. Dirt maintenance factors are discussed more fully in Appendix B.

Market Price of Lamp (P)—For all lamp lives, the lamp retail prices used in the calculations are the following:

Lamp Watts	Price, cents
15	23
25 to 100 inclusive	25
150	33

Labor Cost of Lamp Replacement (h)—The following "handling charges," based on field measurements, cover both lamp replacement and attendant fixture cleaning:

Lamp Watts	Cents
15	8
25	9
40	9
50	9
60	10
75	10
100	11
150	11

Appendix C describes the method of determining these charges.

Average Lamp Life (L)—For each wattage, calculations were made for a range of lamp lives. Lamps are assumed to be left in service until they burn out.

Mean Lamp Watts ($\bar{W}$)—The wattage consumed by lamp bulbs decreases slightly and gradually during life. The use of the mean or average wattage in these calculations is consistent with the use of mean lumens during life for light output. The value of mean watts for each type of lamp is based on tests of lamps of lives which are now currently listed and are assumed to be constant for any lamp life within the range studied.

Energy Rate (R)—Calculations assume 2.43¢/kwh, which is the Electrical World[9] forecast of the average U. S. residential electrical energy rate for 1960.

Annual Fixed Charges (F)—The following values, discussed in Appendix D, include amortized cost of wiring (30 years) and lighting fixtures (15 years) plus estimated cost of taxes, insurance, and interest on the investment.

Lamp Watts	Annual Fixed Charge, Cents
15	37
25	37
40	42
50	51
60	59
75	82
100	110
150	137

Annual Cleaning and Maintenance Cost (M)—Cleaning is assumed to be performed at the time of lamp replacement, or at least once a year if the lamp life is longer. Cleaning is included in the labor of lamp replacement, hence the annual cleaning cost (M) is taken as zero.

Annual Operating Hours (H)—The following estimates of average annual operating hours in residences, by lamp wattage, were made by application engineering specialists in residential lighting. These operating hours were checked to be in agreement with estimated average domestic kilowatt-hours of lighting obtained from recent market-research surveys.

Lamp Watts	Estimated Average Annual Operating Hours
15	300
25	350
40	450
50	530
60	600
75	650
100	675
150	700

Effect of Foregoing Items On Economic Life

Increases in some of the foregoing items in the cost-of-light equation tend to increase economic life, while the reverse is true for other items. These relationships are discussed in Appendix E.

Results

Table I lists the lamp wattages, present design lives, and lamp lives for lowest cost of light.

TABLE I — Residential Lamp Lives Based on Engineering Factors.

(1) Lamp Watts	(2) Present Design Life	(3) Life for Lowest Cost of Light
15	1200	1050
25	1100	1075
40	1000	890
50	1000	710
60	1000	450
75	750	370
100	750	350
150	750	300

The Non-Engineering Factors

In addition to lowest cost of light, other factors of a non-engineering nature may influence the design lives of these lamps for residential service. One example is the inconvenience of making lamp replacements. This inconvenience is over and above the handling charge for lamp replacement and fixture cleaning, which is included in the cost-of-light calculation. It is probably safe to say that most people would be dissatisfied with a design of lamp requiring frequent replacement, even though they were aware that such a lamp design would give them the most light for their money

Another consideration is accessibility and its effect on cost and convenience of lamp replacement. Some bulbs are easy to reach, as in floor or table lamps. Others are more difficult to reach; for example, some are in ceiling sockets, or in enclosed fixtures which require some disassembly. Even though in the typical residence there may be relatively few such lamp bulbs that are not readily accessible, the difficulties in these cases may tend to create an erroneous impression that most lamp bulbs are hard to replace.

Another factor is the trend toward more and more lamp bulbs per home, often accompanied by a trend toward longer average burning hours. The resulting increase in frequency of lamp replacements throughout the home as a whole may convey the impression that "lamp bulbs don't last as long as they used to." Actually, the authors know of no reductions in life ratings of general lighting lamps for more than 25 years.

Still another factor is that certain lamp bulbs in a house are used more hours than the average, and hence burn out in fewer days. As a result, the impression may again be that most of the lamp bulbs in the home must be replaced frequently.

And still another factor is that any increase there may be in the voltage at the sockets will cause filament lamps to burn out at a faster rate. Evidence of increasing standardization on 120 volts appears in a recent report of an independent market survey service. Such standardization helps greatly to insure that lamp bulbs purchased by householders are of voltage rating correctly matching the socket voltage.

It is the judgment of the authors that these various non-engineering factors are taken reasonably into account at this time in the following "non-engineering lamp design parameters":

(1) In each wattage, average lamp life ought to be in the neighborhood of a year or longer, regardless of any cost-of-light advantage for users from shorter lamp life.

(2) No lamp lives ought to be shorter than those now listed and to which users are accustomed, regardless of any cost-of-light advantage which would accrue from shorter lamp life.

These non-engineering lamp design parameters modify the values of lamp lives giving lowest cost of light, in Table I, as indicated in Table II.

Summary

It is the responsibility of the lamp design engineer to build into the product the best over-all value for the average conditions of use. This necessitates providing a proper balance between light output, wattage consumption and lamp life. A proper balance is particularly important in the case of lamps for residential lighting, because retailers usually can justify allocation of space for only a few lamp designs.

Longer life of filament lamps can be achieved only by reducing light output at the same wattage, or by increasing wattage to maintain the same light output.

The lives of today's general-service filament lamps are considerably in excess of those which would give the lowest cost of light under the average conditions of residential service. This is particularly true for the sizes of 50 watts and above that provide most of the light used in residential applications. This extra life, entailing lower efficiency, now results in an extra expense to the American householder of some 30 million dollars a year. Longer lives would increase this extra expense, for which no light would be received. On the other hand, reducing lamp lives to the point where they would deliver best economy would mean more frequent replacements, with attendant inconvenience.

Thus, it is concluded that the present design lives of the general-service line of residential filament lamps indicated in Table II represent a reasonable and proper balance between the two objec-

TABLE II — Residential Lamp Lives Based on Engineering and Non-Engineering Factors.

(1) Lamp Watts	(2) Present Design Life	(3) Life for Lowest Lighting Cost	(4) Life for Lowest Lighting Cost, Within Non-Engineering Design Parameters Stated	(5) Life, Per Cent in Excess of Economic Life*
15	1200	1050	1200	14
25	1100	1075	1100	2
40	1000	890	1000	12
50	1000	710	1000	41
60	1000	450	1000	122
75	750	370	750	103
100	750	350	750	114
150	750	300	750	150

*Per cent by which values in Column (4) exceed economic life values in Column (3).

tives of (1) providing the householder with the lowest cost of light, and (2) minimizing the inconvenience of too-frequent lamp replacements.

Acknowledgement

The authors acknowledge with thanks the counsel of their colleagues—A. C. Barr, O. Phelps Meaker, and others.

Appendix A

The unit cost of light[8] refers to the cost of a given "quantity" of light—one million lumen-hours is the usual figure. The lumen, generally thought of as a quantity, is really a *rate* of output; to obtain quantity generated, it must be multiplied by time. Hence the use of lumen-hours. The unit cost of light may be used for "raw" output of the lamps, as in this article, regardless of the particular lighting system or illumination level. It is not intended for economic comparisons of lighting systems; for these, another type of computation is widely used.[10,11]

The equation simplifies the task of counting up all costs and converting them into dollars per million lumen-hours; this is done by the proper choice of units. Two elements comprise the formula:

I. A factor of $\frac{10}{\overline{Q}\,\overline{D}}$ of which the denominator is mean lamp lumens multiplied by a factor which expresses the mean effect of dirt accumulation on the lamp bulb and on luminaire parts. Its effect is, of course, to reduce the effective mean lumens and hence increase the unit cost somewhat.

II. A factor (in parentheses) which is the sum of three terms, each expressed in cents per 1000 hours of lamp operation:

(1) Costs of lamp and its replacement $\frac{P+h}{L}$. These costs recur each lamp life, hence the installed cost in cents is divided by lamp life in thousands of hours (L).

(2) Cost of energy is mean watts ($\overline{W}$) times energy rate (R). Since the rate is in cents per 1000 watt-hours, this product is already on the basis of 1000 lamp-hours.

(3) Fixed and Maintenance Charges ($F + M$). Since these are *annual* costs, they are divided by *annual* operating hours in thousands (H) to obtain cents per 1000 lamp-hours. $\frac{F+M}{H}$

The sum of these three terms is multiplied by 1000 to convert to a basis of one million lumen-hours. Then that is divided by 100 to convert cents to dollars, hence the 10 in the numerator of Factor I.

For these calculations the lamp bulb and its luminaire have been assumed to be cleaned at the same time and to decrease in output at the same rate—in other words, the factor $\overline{D}$ applies either to the lamp alone or luminaire. It varies up to one year, at which point annual cleaning is assumed to begin. It then remains constant at an average value applicable for all longer periods. Dirt maintenance factors are discussed more fully in Appendix B.

By evaluating the unit cost of light (U) with the equation presented in the text, for various lives (with their associated values of $\overline{Q}$ and $\overline{D}$), the life for minimum cost of light is readily found. Fig. A-1 shows the result of three such calculations for the 100-watt lamp with 350 hours being the life for minimum unit cost of light. Mean lumen and maintenance factor values are given in Table A-I.

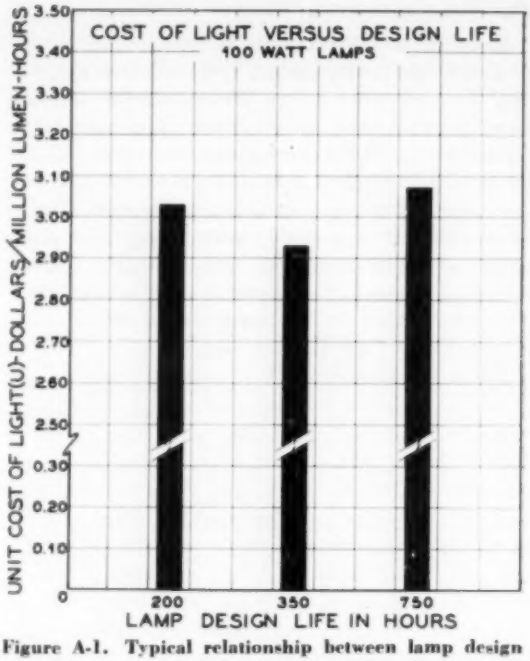

Figure A-1. Typical relationship between lamp design life and unit cost of light, for three life values, one of which provides light at minimum unit cost. This chart applies for lamps of 100 initial watts for all design lives, with cost and usage data as given in the text for residential lighting service.

If all the variables can be presented in terms of life (L) the first derivative of the cost-of-light formula may be equated to zero and solved for L_1, the life value that will provide light at the lowest unit cost. For example, the dirt maintenance factor may be of the form shown in Appendix B and mean lumens ($\overline{Q}$) might be taken as a simple function of L:

$$\overline{Q} = CL^{-\frac{1}{\phi}}$$

where: C is a constant depending upon the lamp size and type, ϕ is determined by the life-efficiency relationship at constant design watts.

In this case, the following equations for economic life, L_1, may be used:

(I) *For constant dirt Maintenance Factor.*

$$L_1 = \frac{H(\phi - 1)(P + h)}{WRH + F + M}$$

TABLE A-I.

Average Lamp Life in Hours	Mean Lamp Lumens—($\overline{Q}$)	Average Dirt Maintenance Factor—($\overline{D}$)
200	1985	0.968
300	1861	0.955
350	1816	0.949
400	1778	0.943
500	1717	0.931
750	1610	0.913

TABLE B-I—Constants Applicable to Residential Service.

	15- and 25-watt lamps, no fixture	Other lamps with fixture
Assumed Maintenance Factor (D) at 12 months	0.95	0.85
A	0.90	0.75
a	0.057763	0.076358
Constant value of $\overline{D}$ for L values equal to or greater than H	0.972	0.913

(II) *For variable dirt Maintenance Factor* (expressed exponentially, Appendix B) the following expression is obtained, the two sides of which may be evaluated for perhaps four values of L_1 and plotted to obtain a graphical solution for L_1 at the intersection of the two curves.

$$\frac{H(1-A)}{12a}\left[\frac{-\frac{12aL_1}{H}}{1-e}\right]\left[(1+\phi)B+\frac{K}{L_1}\right]-A\phi K=\left[\frac{-\frac{12aL_1}{H}}{(1-A)\phi e}-A\right]\left[K+BL_1\right]$$

where: $B=\overline{W}\ R+\dfrac{F+M}{H}$

$K=P+h$

A, a = constants for dirt maintenance curve. (See Appendix B.) Other symbols as above.

Appendix B

Maintenance Factors

It is recognized that even in residences, the maintenance conditions in respect to accumulation of dust and dirt on lamp bulbs and fixture reflectors and shades vary widely. However, for purposes of these calculations, average maintenance factors have been chosen for fairly clean conditions. Cleaning is assumed to occur on lamp replacement or at least once per year for both bulbs and luminaire parts. The factor $\overline{D}$ is given by the following equation:

$$\overline{D}=A+\frac{H(1-A)(1-e^{-\frac{12aL}{H}})}{12aL}$$

where A = a constant representing the asymptote of the maintenance factor curve or the minimum value with no cleaning.

a = a constant determined by the shape of the maintenance factor curve.

Others = as in unit cost-of-light equation.

Fig. B-1 shows the plotted curves of average maintenance factor ($\overline{D}$) for these constants used in the equation above.

When the average maintenance factor is constant in the life region of interest, it has no effect on economic life. If maintenance factor decreases with longer life, it tends to reduce the indicated economic life.

Appendix C—Lamp Bulb Replacement or Handling Charge

There is seldom an actual expenditure in payment for lamp replacements and fixture cleanings in residences. Nearly always these things are done, not by a maid or other hired help, but by some member of the household. Although this involves no cash out-of-pocket, there is a cost in time and effort, and economic calculations should include a "handling charge" to reflect the time involved at an appropriate hourly rate.

For this article determination of an up-to-date charge was made in four steps:

(1) Set-up of three classifications of residence lighting fixtures from the standpoint of accessibility of the lamps—easy, moderate, or difficult to reach.

(2) For each lamp wattage, apportionment of presently-used residence fixtures into these three classifications.

(3) Measurements of handling times for lamp replacements and fixture cleanings, covering a cross-section of residence lighting fixtures in service in the three classifications.

(4) Determination of a proper hourly rate to convert the handling times to handling charges.

Fixture Classifications

The time involved in lamp replacement and fixture cleaning depends in large measure on the type of fixture and its accessibility. To take account of such differences the three following classifications of residence fixtures were set up:

Class 1—Fixtures in which lamp replacement requires neither climbing nor taking the fixture apart in order to gain access to the lamp. Examples are bare lamps or lamps in open-bottom shades within reach from the floor, portable lamps with or without diffusing bowls of glass or plastic, and wall brackets with lamps bare or in simple shades. Many of these fixtures involve no cleaning or a simple dusting. Others, such as portable lamps with bowls, involve

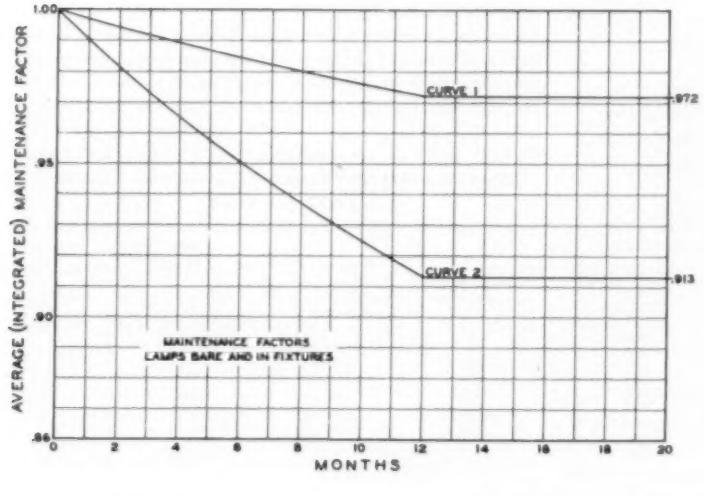

Figure B-1. Average Maintenance Factors used in this article to allow for the mean effect of dust and dirt accumulations on light output of lamp bulbs. Curve No. 1 applies to bare lamps only, and is used for 15- and 25-watt lamps. Curve No. 2 includes the effect of dirt accumulation on fixture parts as well as on lamp bulb, and applies to lamps of 40 watts and above.

cleaning of the bowls, either in place with a wet cloth or preferably by removal and regular washing.

Class 2 — Fixtures in which lamp replacement requires climbing, but *not* taking the fixture apart to gain access to the lamp. Examples are bare lamps or lamps in open-bottom shades *not* within reach from the floor. As in Class 1, many of these fixtures involve no cleaning or a simple dusting. Others, such as ceiling fixtures with open-bottom glass shades, involve cleaning of the bowls, either in place with a wet cloth or preferably by removal and regular washing.

Class 3—Fixtures in which lamp replacement requires taking the fixture apart to gain access to the lamp. Most of these fixtures also require climbing. Examples are recessed, surface-mounted, or suspended fixtures in which the lamps are enclosed or are mounted above glass or plastic bowls or plates of such contour and position as to interfere with access to the lamps. Increasing numbers of these fixtures are of multi-lamp designs. Proper cleaning of the glass or plastic elements nearly always involves removal and regular washing.

Proportions of Fixtures in Three Classifications

Table C-I gives the estimated proportions of residence lighting fixtures now in service in the above three fixture classifications, broken down by the wattage of the lamps employed in them.

In calculating the above percentages, a 1938 survey of 1013 homes by E. W. Commery[12] was used as the best data available. The distribution of these 1013 homes—in size, locality, and income and between rental and owner-occupied—was carefully selected to be representative of a large majority of homes. It omitted the highest and lowest income groups. The information from this survey was modified by experienced residential lighting application engineers in accordance with their knowledge of current conditions, practices and more recent pertinent information.

Handling Times

Invitations to participate in measurements of the handling times in lamp replacements and fixture cleanings in their own homes were accepted by nine men and nine women. They were Nela Park employees, their spouses, and friends. Sixty-five such measurements were made—34 on Class 1 fixtures, eight on Class 2, and 23 on Class 3. Within each fixture classification, an attempt was made to obtain a reasonable cross-section of the variations of fixture designs in use. All participants were instructed to carry out the replacement and cleaning steps just as they normally would, and to make the operation complete. For example, if a piece of glassware were to be washed, the time was to include the steps of getting a wash cloth and a cleanser, the actual washing, getting a cloth for drying, the actual drying, and putting away the cloths and cleanser. As another example, if a participant stood on a chair with one foot on a dining table, the time was to include removing his shoes and putting them back on. Particularly, all participants were instructed to proceed at a normal pace.

The average handling times for lamp replacement and fixture cleaning are shown in Table C-II.

TABLE C-I — Estimated Proportions of Residence Lighting Fixtures in Service in Three Classifications.

Watts	Per Cent in Class 1	Per Cent in Class 2	Per Cent in Class 3	Total Per Cent
15	40	55	5	100
25	40	50	10	100
40	40	45	15	100
50	40	45	15	100
60	40	30	30	100
75	50	20	30	100
100	50	10	40	100
150	50	5	45	100

TABLE C-II — Average Handling Time for Lamp Replacement and Fixture.

Fixture Classification	Average Handling Time, Minutes In Trials	Used in Calculations
1	4.0	4
2	5.0	5
3	9.3	10

Hourly Rate

A rate of $1.00 an hour is judged to be appropriate for lamp replacement and fixture cleaning. Such work is in the nature of janitor and cleaning service for which the National Minimum Wage is $1.00 an hour. In the case of household maid service, to which the National Minimum Wage does not apply, a rate of $1.00 an hour is undoubtedly high nation-wide, although it may apply as an average in large northern cities.

Calculation of Handling Charge

The average handling charges, in Table C-III, for lamp replacements and fixture cleanings are computed from Tables C-I and C-II, for a rate of $1.00 an hour.

Appendix D—Fixed Charges

Lighting costs properly include the fixed charges on the installed cost of lighting facilities such as wiring, fixtures and switches. The Fixed Charges cover amortization, interest, taxes and insurance.

Investment

Table D-I gives estimates of average investment per socket—related to lamp watts—for wiring and fixtures. These estimates were made with the assistance of experienced residential lighting application specialists.

Amortization Periods

Bulletin F, "Tables of Useful Lives of Depreciable Property," Publication No. 173, Internal Revenue Service,[13] lists life of conduits and fittings at 60 years (life of dwellings) and wiring at 20 years. An average life of 30 years for wiring[14] is judged to be consistent with these values, and takes into account the periodic additions to and modernizations of house wiring installations. Annual wiring amortization—3.3 per cent.

An average life of 15 years for lighting fixtures in buildings is given by the above Bulletin and is judged by experienced residential lighting specialists to be representative for that service. This life takes into account replacements

TABLE C-III — Average Handling Charges for Lamp Replacements and Fixture Cleanings for Rate of $1.00 per Hour.

Lamp Watts	Average Handling Time, Minutes	Approximate Average Handling Charge (h), Cents
15	4.9	8
25	5.1	9
40	5.4	9
50	5.4	9
60	6.1	10
75	6.0	10
100	6.5	11
150	6.8	11

Values in third column have been used in cost-of-light calculations.

TABLE D-I—Average Investment Per Socket for Wiring and Fixtures, as Related to Lamp Watts.

Lamp Watts	Investment per Socket in Wiring	Investment per Socket in Fixtures
15	$2.50	$1.67
25	2.50	1.67
40	2.85	1.90
50	4.00	2.00
60	5.00	2.00
75	6.00	3.50
100	7.50	5.00
150	9.00	6.50

of lighting fixtures due to breakage or failure of the switch or some other component, and also replacements attributable to new light sources, style changes, or increased lighting levels. Annual fixture amortization—6.7 per cent.

Interest, Taxes, Insurance

Interest, taxes and insurance rates are judged to apply equally to wiring and to fixtures.

An interest rate of five per cent a year is judged to be a conservative average. Taking amortization into account, this interest rate may be applied to half of the investment. More simply, an interest rate of 2.5 per cent may be applied to the full investment.

A tax rate of 3.8 per cent ($3.80 per $100 valuation) on an assessed valuation of one-third of actual investment was chosen as representative. This amounts to about 1.3 per cent on the estimated investment.

An insurance rate of 0.4 per cent ($0.40 per $100) on a valuation of 80 per cent of the actual investment was chosen as representative. This is about 0.3 per cent on investment.

Annual Fixed Charges

The sums of the foregoing percentages are:

	Wiring	Fixtures
Amortization	3.3	6.7
Interest	2.5	2.5
Taxes	1.3	1.3
Insurance	0.3	0.3

These fixed charge percentages, costs in wiring and fixtures given under "Investment" above, result in the estimated values of total annual fixed charges shown in Table D-II. These values are also given in the text of this article.

Appendix E—Effects of Changes in Variables on Unit Cost and Economic Life

The direction in which the variables of cost factors and lamp characteristics affect cost of light and economic life of lamps is often of interest.

The effect of each variable on unit cost is apparent from the equation. *Increases* in mean lumens, average maintenance factors, lamp life and annual burning hours tend to decrease the unit cost per million lumen-hours. *Decreases* in the other quantities—price and handling charges, watts, energy rate and annual fixed and maintenance charges—also decrease the unit cost of light.

The changes in economic life due to changes in these variables are less apparent. Economic life increases as lamp price, handling charge and annual operating hours *increase*. Also, *decreases* in wattage, energy rate and annual charges have the same effect. With respect to economic life the absolute value of mean lumens has no significance, but the relationship between effective mean lumens at different hypothetical lives is pertinent. For example, an unusual reduction of mean lumens or in dirt maintenance factor for a hypothetical longer life would in itself have the effect of indicating a shorter life because unit cost would tend to rise more rapidly at the longer life values.

TABLE D-II — Estimated Values of Total Annual Fixed Charges.

Lamp Watts	Annual Fixed Charges per Socket In Wiring	In Fixtures	Total
15	$0.19	$0.18	$0.37
25	0.19	0.18	0.37
40	0.21	0.21	0.42
50	0.30	0.22	0.51
60	0.37	0.22	0.59
75	0.44	0.38	0.82
100	0.56	0.54	1.10
150	0.67	0.70	1.37

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Applications for Retired Membership

By action of the membership of IES, retired membership classifications are available to qualified members. Privileges in these grades include reduced annual dues ($5.00) and the continued receipt of all mailings, including Illuminating Engineering. Classifications are known as Member, Retired; Fellow, Retired; Associate Member, Retired. Those interested and qualified (at least thirty years of membership in the Society and 65 years of age) should write to the General Secretary at Headquarters, stating that they have retired.

Lighting for

Choir-boy scene (above) painted on plywood attached to front door is floodlighted and outlined in greens and lights attached to outside of door frame. Two jumbo plastic candles at side are lighted from within.

Tree on this door (right) is tinsel roping basted to red oilcloth background and floodlighted from lawn. Pillars are wrapped with evergreen roping studded with outdoor Christmas lights backed by tinfoil stars. Strings of outdoor lights with metal ground stakes outline the path from driveway to entrance.

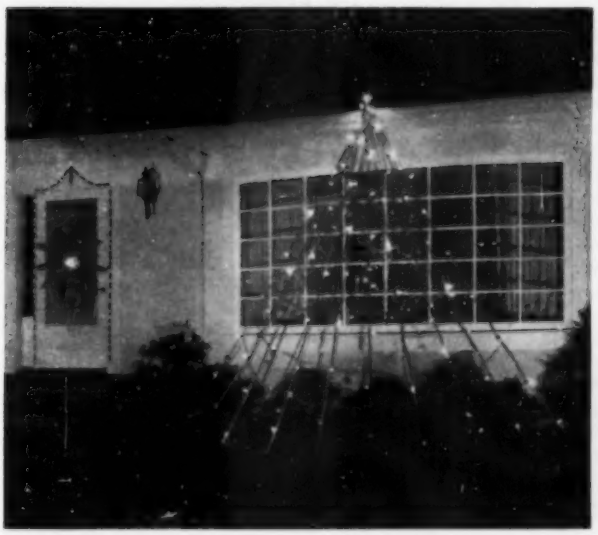
Beautifully decorated doorway to an interior designer's home. Madonna is floodlighted from lawn. "Do-it-yourself" candles are plaster of Paris. Madonna is an original oil painting on canvas (by Pearl Jennings) cut out and applied to gold metallic fabric background.

Striking doorway decoration is made from plywood painted gold. Angel and harp are mounted a few inches out from door and backed by white Christmas bulbs to give silhouette effect. Lights in evergreen at edges and spotlights on door and lawn complete the ensemble.

Holiday Splendor

By EVE FREYER

Secret of this tastefully decorated house is balanced simplicity. Huge homemade wreath serves as background for 20 ten-watt S11 lamps. "Seasons Greetings" are wooden letters mounted against diffusing plastic in front of wooden trough housing ten-watt S11 lamps on eight-inch centers. Candles were homemade. Whole house is floodlighted but, in addition, spray on front door is subtly accented by 30-watt R20 lamp in swivel socket screwed into the fixture over the entranceway.



Simulated tree made from tinsel roping and lights fastened to wire frame. Strips of foil tinsel are hung inside window. A similar yard decoration might be used to frame a lighted indoor tree viewed through a picture window. Floodlights aimed on front facade add emphasis to the whole.

AUTHOR: Westinghouse Lamp Division, Bloomfield, N. J.

Christmas card "tree" serves dual purposes of displaying cards and taking the place of a decorated evergreen. Tree is of heavy green cardboard tacked to gold painted wooden frame drilled with holes for Christmas lamp sockets. Wire of Christmas strings is concealed behind the frame. The whole tree is floodlighted from the sphere at right. Both tree lights and floodlight are plugged into 150-watt table lamp dimmer to control brightness.

Each year the family living in this house chooses a standard Christmas greeting card and reproduces it on their front door. Enlarging the design, painting it in oils on plywood (in this case even sprinkling with glitter to match card) does not require the talents of an artist. Note spotlight at lower right concealed behind evergreen boughs.

Proposed Method of Measuring the

Hiding Power of Light Shielding Materials

(Discussion and rebuttal of a paper by W. O. Benjamin and C. W. Clarkson, published in November ILLUMINATING ENGINEERING)

WILLARD ALLPHIN:* I think the authors have chosen unfortunate phrases in "hiding power factor" and "obscuring power factor." Electrical engineers have used "power factor" for many years to mean something quite specific but quite different. Furthermore, the usage gets into our field in regard to fluorescent lamp ballasts. It should be easy to find another term, such as "hiding index" or "hiding power index" which would avoid confusion.

H. F. DAVIDSON AND J. M. CHORLTON:** The rating system suggested here should be useful in architectural and sign lighting where one is concerned with a uniform brightness at specific angles of view. We question whether the suggested method gives sufficient information to be of use in a consideration of reflected or direct glare which is concerned with a wide range of viewing angles.

Reflected glare has two aspects, as described in the *IES Lighting Handbook*, Third Edition pp. 11-25. One aspect is within the task where reflected glare can change the contrast between the object and its background. The other aspect, and the one more commonly thought of, is outside the task proper, and results in annoyance and distraction caused by the images of bright sources reflected in glossy surfaces within the field of view. It is important when referring to reflected glare to make clear which aspect is meant.

Reflected glare that changes contrast in the task is not concerned so much with the brightness of the source but with the proportion of the total light on the task that arrives at or near the mirror angle with respect to the observer's line of sight. As long as the same proportions and footcandle levels exist the effect on the contrast in the usual office or school task will be the same whether the task sees bare lamps or a diffuser in the bottom of a luminaire. It is the amount of light falling on the task from different directions that is important rather than the source brightness. This does not apply in special cases where the task approaches perfect specularity as in working with glossy materials such as sheet metal and plastics.

The other aspect of reflected glare, that is the reflection of bright images from surfaces outside the task proper, is affected by the obscuring or shielding properties of the diffuser. However, in this case, as with direct glare a variety of angles must be considered and it may be that a rating system based on the polar distribution of brightness of the diffuser could provide more information than the system suggested by the authors.

R. D. BRADLEY:† The expanded definitions of "louvering, refracting and diffusing" phenomena are concise and very well explained.

While this paper does not deal with glare problems, except indirectly, it is suggested that recognition could be made of direct glare problems as well as of reflected glare. Later in the paper, two systems of direct glare evaluation are mentioned, but are not mentioned in the introductory statements.

Reflected glare studies are beginning to clearly point out that *all* tasks have the property of producing reflected glare even though one would not classify their surfaces as "glossy." Finch, Chorlton and Davidson[1] point this out and imply that reflected glare is not a property of the brightness of the source but rather is directly related to the percentage of light flux striking the task at the mirror angle. While this has little bearing on the subject matter of this paper, it may help evaluate the importance of hiding power. Appearance factors are quite important but very hard to tie down scientifically. I feel that appearance is probably the *most* important function of hiding power and that this work will prove helpful in analyzing this concept.

It might have been more appropriate to have chosen 25 degrees in place of 30 degrees as the observation angle, as this constitutes the "mirror" angle used by several other researchers in the study of reflected glare.

PHELPS MEAKER:* This is a paper which opens up for discussion a subject which is way overdue. It is important from the standpoint both of providing an opportunity to get our ideas and terminology straightened out, and of rendering a service to the industry in helping them to appraise the comparative characteristics of shielding and obscuring materials.

In the description of transmitting media it seems that there should be recognition of those glasses and plastics which display a combination of regular and diffuse transmission. An official definition is on record:

> "*30.012 Incomplete Diffusion:*
> Incomplete (partial) diffusion is that in which the diffusing medium re-emits some of the flux incident upon it in an image-forming state and another portion in a non-image-forming state." (ILLUMINATING ENGINEERING, November, 1957.)

There are a rather limited number of glasses which display this characteristic, but among the plastics there are enough so that some workers in this subject have concluded that hiding power relates to the ability to conceal the sharp outlines of a source, such as a fluorescent lamp. It appears that the authors have not taken this situation into account since their instrument does not indicate whether there is a perceptible component of regular transmission.

The authors have mentioned the glare factor and visual

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**Curtis Lighting of Canada, and Board of Education, City of Toronto, respectively, Toronto, Ont.
†Day-Brite Lighting, Inc., St. Louis, Mo.

[1] "The Effect of Specular Reflection on Visibility"—Finch, D.M.: Part I—"Physical Measurements for the Determination of Brightness and Contrast;" Chorlton, J. M. and Davidson, H. F.: "Part II—Field Measurements of Loss of Contrast," ILLUMINATING ENGINEERING, Vol. LIV, No. 8, pp. 473-488 (August 1959).
*Lamp Division, General Electric Co., Cleveland, Ohio.

comfort index rating systems. In view of the current work described in RQQ Committee Report No. 6 (July 1959 IE), and the promise even of an international agreement as to the proper weight to be given the various factors involved, it seems unwise to go on record as saying, for instance, that an index of discomfort due to direct glare is proportional to the square of brightness. While the glare factor approach has been a useful interim procedure, more scientific evaluations are on the way.

In devising an instrument and a procedure such as this, it is always necessary to make arbitrary decisions, and the one-quarter-inch aperture is of this nature. It is feared that some people will object to a method of recording which gives, for instance, a gradient of 12.5 for a fluorescent lamp against a black background where the actual gradient is perhaps a hundred times this if not infinitely great. This, of course, is of the same nature as the previous mention of the fact that the instrument as described will not detect qualitatively an element of regular transmission. Furthermore, it would appear that the gradient in question is a function of the lamp brightness, rather than any characteristic of the source associated with diffusion or obscuring. Accordingly it would be possible to obtain a much higher gradient on another lamp of twice the brightness, but both figures would represent the same situation as regard obscuration of the source.

It should be mentioned that in Table I the data with a white-enameled backing are quite inconclusive, since the distance to the backing, and hence its brightness, is not stated. Work with a white back opens up a whole new range of possible variables. Particularly in the case of diffusing samples, great care must be exercised that the length of lamp exposed to the sample be uniform and standardized in all cases. It is believed that an arbitrarily-set length of lamp, at least no greater than the width of the sample, should be employed for all testing, and the specimen located opposite the center. It will be clear that the diffuse illumination at the incident side of the diffusing specimen will have a good deal to do with the brightness gradient effective in the test. If this illumination comes from parts of a lamp which are not directly behind the specimen, it will be seen that results can change considerably, depending upon the specific conditions. This brings up the question as to whether a set of readings with one source adequately expresses the hiding characteristics when two lamps are placed side by side, as is often the case in fluorescent luminaires.

As mentioned previously, the citing of a finite value of brightness gradient to a bare fluorescent lamp is a questionable matter. If the rating of an obscuring specimen is based upon such a figure for a bare fluorescent lamp, the latter assumes considerable importance due to its influence on the character of the rating scale as a whole. In addition, such a scale will not have much meaning if we want to use a specimen for obscuring a filament lamp.

It would be interesting to know whether the authors have made any tests by their method to show the difference between obscuring power with the rough and smooth sides of configurated media placed toward the lamp.

Some efforts have been made toward rating media with partial diffusion in terms of the distance from the sample to the source at which some agreed-upon degree of obscuring takes place. So far this has been rather unsatisfactory. It is believed that this failure may result in part from the fact that as a lamp is drawn away from a specimen the diffused illumination on the incident side decreases, while the source brightness remains constant, giving rise to some very puzzling anomalous results.

The idea of rating in terms of brightness gradient seems good fundamentally. Some time ago the following tentative definition was drafted, and is inserted here for purposes of discussion:

> "Hiding power relates to the degree, completeness and spectral selectivity of diffusion of a light-transmitting material, as a result of which a scene composed of heterogeneous brightnesses, viewed through the medium, presents to an observer a brightness gradient more uniform than the scene itself."

WARREN BENJAMIN AND CLARENCE CLARKSON:* Mr. Allphin's comment concerning the "power factor" portion of OPF is a good one. Actually, it will be satisfactory to use the term "Hiding Power," which is now in common use, since its abbreviation HP could not be misconstrued to stand for "horsepower" in connection with light shielding media.

As suggested by Messrs. Chorlton, Davidson, and Bradley, with the present status of work on so-called "reflected glare," and also on the proposal for measuring hiding power, the two do not seem to be related. However, neither program is in final approved form, both requiring considerably more data collection. The authors are not discarding this part of their proposition, but do intend to concentrate first on an acceptable rating of materials in terms of hiding power before further considering various possible uses of the rating system.

Since there are two extremely different concepts of "reflected glare," as mentioned by Messrs. Chorlton and Davidson, the authors suggest discarding the term "reflected glare" and adopting two new terms in its place. One might be "discomfort glare, or blint, or distraction glare" for that which is reflected from an object outside the task. The other form of "reflected glare" is not necessarily uncomfortable, but obscures the task by loss of contrast, and might be referred to as "veiling brightness" or "veiling reflectance."

As Mr. Meaker suggests, the gradient of the bare lamp is not as high as one would expect theoretically, partly due to aperture size, and partly due to some reflection from the black velvet background in the area adjacent to the lamp. Further testing is being arranged with the background farther from the lamp, and using a light receiver that will allow a much narrower aperture.

Although a white background will help in the "hiding" of the light source, the authors feel that a matte black background is a more easily duplicated condition for a standard test procedure. There is considerable concern over the effect from variation in paint reflectances and finishes, deterioration, distance of reflector from the lamp, reflector shape, etc. It is recognized, however, that eventually it will be necessary to do some evaluation of this rating system in connection with fixture design.

If the length of the lamp exposed to the specimen is longer than the specimen is wide, there will be a tendency for diffusing media, especially those with a roughened surface toward the source, to appear to hide the source better than they should, in comparison with the effect on clear, patterned materials.

Test data mentioned in the paper were taken with all materials in their normal operating positions. Inverting the pieces will give the same results if the surfaces are relatively plain, but different results if the surfaces are markedly different. This should, and will, be investigated further.

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*Authors.

Application Possibilities of

Wide Range Dimming of Fluorescent Lamps

(Discussion and rebuttal of a paper by P. E. Massie and A. B. Rosenstein, published in October ILLUMINATING ENGINEERING)

B. F. JONES:* Applied to a range of commonly used lamps, this wide-range flickerless dimming system should be of substantial benefit in commercial interiors. From a commercial and industrial application standpoint, it should be noted that an extremely wide range such as is attained by this system is not necessary, since extremely low levels can be more economically attained by the use of a second, low-level system. Freedom from flicker, however, is very important. Weight is not too important, but size and cost are vital.

For the many applications of dimmer systems we often encounter, a system such as is described here which will dim 800- and 1500-milliampere lamps would be extremely useful, but it must be economically practical and must not introduce problems of conformance with national, state and local codes. I notice that the ballasts mentioned are low power factor. What are the chances of getting high power factor ballasts for these lamps? Also, only single-lamp ballasts have been discussed. Can a two-lamp ballast for this system be built at less than twice the size and cost of a single-lamp ballast? Most of our fixture designs are based on the two-lamp ballast and the availability of a two-lamp dimmer ballast could result in substantial savings in manufacturing cost.

T. S. MADONIA:** I read with interest the authors' previous papers which discussed the technical aspects of timing circuitry and components. Their versatility is shown by this paper which discusses dimming from a broader and less technical view.

However, in attempting to minimize the technical details, they may have created an erroneous assumption in certain reader's minds that preheat lamps can be dimmed as well as rapid start lamps. This is true only if the circuit characteristics are adequate to provide reliable starting and still permit uniform lamp brightness and smooth transition of brightness. The cathode heater circuit of the ballast must be designed to maintain the lamp electrode condition slightly below end-glow at the maximum input line voltage to the ballast. This will assure a smooth transition in lamp brightness as the control is varied. If the heater circuit does not provide adequate heating of the lamp cathode, low lamp brightness is maintained as the control is varied and then a "jump" to a higher brightness is experienced. If the heater circuit causes constant end-glow, the undesirable condition exists of bright lamp ends when the arc of the lamp is dimmed to low brightness.

P. E. MASSIE AND A. B. ROSENSTEIN:† The authors appreciate the courtesy of the discussers in their comments on the paper. Mr. Jones points out that the wide range of dimming noted in the paper is not necessary in commercial applications. This may be true for certain applications, such as factory lighting, where it is desired to take advantage of natural light and effect a power saving. For theatre or auditorium lighting, dimming of at least three orders of magnitude is desirable since eye adaptation over an extended period of time permits the viewer to operate in these low levels.

Two ballast styles may be desirable, one with about two orders of magnitude range and one with more than three orders of magnitude range. Conformance with codes is a problem to be worked out. Research and development is in progress with a copy of the Underwriters' Laboratory requirements "at the elbow." When a market exists, application will be initiated for approval.

Power factor can be solved at present only by fixed capacitor correction on individual ballasts. This poses the necessity for compromise. Shall the power factor be 80 per cent at full bright and supply limited leading reactive power at dim or shall it be ninety per cent or more at full bright and supply larger amounts of leading reactive power at dim? Two-lamp series ballasts for this system are practical if the lamps are not dimmed beyond two orders of magnitude. At low current levels, balancing networks are required to keep the same brightness on both lamps. It may be possible to design satisfactory two-lamp series ballasts with three orders of magnitude dimming but it has not been tried yet.

The series ballast should effect appreciable cost reduction. The cost of dimming ballasts will be appreciably higher than single-level ballasts for some years. For improved operation, the customer should expect to pay more.

Mr. Madonia questions dimming of preheat lamps. The initial studies on the saturable reactor system were accomplished on F13T5 preheat lamps. It is necessary to operate the filaments at an adequate temperature with continuous, fixed voltage power. It is desirable to have silicone coating on the lamp but not absolutely necessary. The problem he poses of a "jump" in the light output as the level increases is typical of cold filament operation. End glow with preheat lamps seems to be little worse than with rapid start lamps. The lamp diameter seems to play a larger part in the amount of visible glow. The end glow does not become objectionable at low levels unless the lamp is viewed directly. Tests have indicated that the light output due to end glow is somewhere in the fifth order of magnitude in relation to rated light output. The rough rule of thumb in setting operational levels for preheat lamp filaments has been to run them at a "dull cherry red," whatever that means. On dimming circuits, all lamp cathodes should be operated at a slightly higher filament temperature than for single-level operation.

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†Authors.

NATIONAL ENTRY
CLASS II

Dial Your Atmosphere

REMODELING and relighting to increase business is a familiar tune. In the case of Kim's Steak House in Salina, Kans., business *was* good, but it was "diner business" and the restaurant wanted to expand its facilities to attract customers for leisurely dining on five-dollar steak dinners. At the same time, of course, the owner wanted to retain his profitable lunchtime trade.

Obvious solution—redecorating and relighting, coordinated from the start, to produce the versatility demanded by such plans.

The new look called for an Oriental motif with a Western accent—flat black walls decorated with framed silk tapestries; black tables, chairs and booths with coral and cream trim; light gray floor. The Western touch was introduced by a mural, eight feet high and 16 feet long, depicting a Rocky Mountain scene.

In addition to the usual problems of color rendition of food and complexions and the already-mentioned requirement of flexibility, there was one structural complication in the area—a supporting beam extending 11 inches down from the old ceiling. The beam and old ceiling were covered with acoustical tile, leaving a final ceiling height of seven feet four inches, with an 11-inch plenum. General lighting system, framed flush into the furred acoustical ceiling is six-foot square pads of vinyl plastic diffusers lamped with four 40-watt warm white deluxe rapid-start fluorescent reflectors and four colored 100-watt incandescents. To eliminate harsh surface brightness differences on the plastic shield-

Neil J. Thompson

Heart of America Section

Midwestern Region

Mr. Thompson, who won first prize in the Midwestern Regional MMILJ contest with this installation, is with The Kansas Power and Light Co., Topeka, Kans.

Kim's "Diner" before remodeling was lighted by bare fluorescent strip. Note structural beam extending 11 inches down from ceiling.

ing, lamps were inverted with maximum light output directed upward. Fluorescent lighting is regulated by an auto-transformer dimmer; incandescent lamps are on separate dimmer control.

Pre-planning and integration of lighting and decorating made it possible to install a soffit for drapery illumination. The acoustical ceiling was stopped nine inches from the wall and 40-watt warm white deluxe rapid-start fluorescent lamps in dimmer strips were installed in the soffit to display, to full advantage, the attractive and carefully chosen draperies.

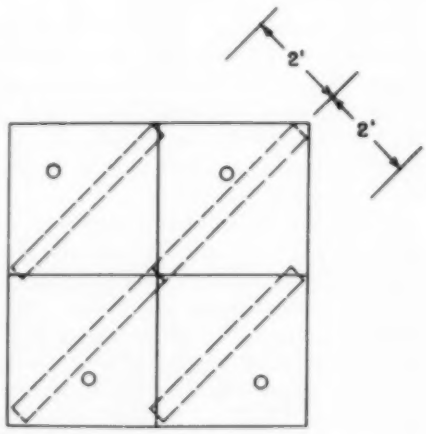
Mural lighting, concealed behind a cornice, is from 40-watt rapid start dimmer strips with asymmetric reflectors to produce even illumination distribution over the entire surface of the mural. This lighting too has separate dimmer control to facilitate subtle variations of mood.

Seventy-five-watt R30 floods in semi-recessed eye-ball units highlight the framed tapestries which decorate the restaurant walls. Since the tapestries have an almost white background and the surrounding wall is black, beam control of the accent lighting was not critical.

With lighting dialed to full brightness, lunchtime customers dine quickly in pleasant, efficient surroundings. At dinner time, with the lighting dimmed and the colored incandescent lamps adding an aura of warmth, Kim has more than fulfilled his desire for an evening trade. Night after night customers must be turned away. There simply isn't room enough for all comers.

Cross section (below) showing F40 T12 warm white deluxe rapid start reflector lamps inverted, in 11-inch plenum, to direct maximum light upward and eliminate brightness differences on plastic below.

Detail of general lighting panel (right) shows arrangement of fluorescent reflector and colored incandescent lamps.



A New Method for Studying Effects of

Direct Sunlight on Building Interiors and Subsequent Skylight Studies

(Discussion and rebuttal of a paper by B. H. Evans and Matthew Nowak, published in November ILLUMINATING ENGINEERING)

J. W. GRIFFITH:* The system for studying direct sunlight as outlined in this paper is essentially the same system used at S.M.U. in the Daylight Study Project concluded in 1958, the primary difference being that the S.M.U. technique employed two lamps to simulate sun conditions. This was found necessary in order to give uniform distribution of sunlight over the fenestration area when direct sunlight on the fenestration was being studied. Furthermore, the two sunlamps produced an area source which simulated the high sky brightness immediately surrounding the sun.

In using the technique outlined in this paper for studying the over-all effect of daylight on buildings with fenestration walls, it is desirable to break the study down into three component parts. These are the effects of direct sunlight, skylight and illumination from below the horizon. Using the three components, one test can be used to determine the effects of daylight over a wide range of conditions.

The addition of the direct sunlight equipment to the Daylighting Laboratories at Texas A & M should greatly enhance the usefulness of the Laboratory to architects in the area. Forthcoming data collected at the Experiment Station should prove valuable to both architects and illuminating engineers. It will be doubly valuable to the illuminating engineer in that it acquaints him with the effects of daylight and at the same time will provide additional data to compare with analogue computing techniques for daylighting.

EDWARD LINFORTH:** This paper is, in fact, two papers as the title suggests. In the interest of brevity this discussion will be confined to the second part which deals with skylighting, leaving the first part to the photometrists except for the observation that there is a real need for a quick and sure technique for preliminary evaluation of daylight environments resulting from new and unusual architectural forms and controls. The authors are to be commended for their efforts in this direction.

In the second part of the paper the authors are primarily concerned with the brightness of skylight domes. Though much is said with which there can be no disagreement, both the data and discussion may tend to confuse rather than clarify the problem. It is suggested that the brightness contrast between task and dome may be reduced by increasing skylight area and reducing skylight transmittance. This is certainly sound advice; but in the next paragraph the authors conclude that "... the data in Fig. 10 indicate ... that the value of the ceiling dome is somewhat limited." In my opinion, there is nothing in Fig. 10 to justify this conclusion. The sections suggest that the data are ratios of illumination on a horizontal plane at an unspecified distance vertically beneath the domes to the brightness of the domes at the zenith, which may or may not be the brightest area, depending on the elevation of the sun. It should also be noted that the inner dome in the left hand section is not properly a ceiling dome, being mounted at the top of the well rather than in the plane of the ceiling. These data do suggest, however, that the distribution of light by single domes of low transmittance is very nearly the same as the distribution by two combined as shown.

The effectiveness of ceiling diffusers lies in the fact that they mask the "hot spot" on the inner surface of the dome on a line of sight toward the sun and provide a room source of uniform brightness. This means that the ratio of equivalent skylight brightness, which is equal to the net efficiency of the entire skylight fixture (comprising dome, well and diffuser), to maximum source brightness is 1.0. Without a diffuser, this ratio is necessarily less than 1.0 and varies with dome density, solar elevation, and well index and reflectance. For domes of three commonly used types, white translucent W-7328 and W-2447 3/16-inch-thick and the metallic fabric type, with the sun at an elevation of 44 degrees, a well index of 0.4 and reflectance of 80 per cent, these ratios are .47, .38 and .25, respectively. These values are based on brightness and net efficiency studies reported in a paper by the writer.[1] Comparable ratios for the other three types with which the authors are concerned are: W-7508, .61; W-7414, .59; W-7420, .49. These latter ratios were derived from measured dome transmittances and graphically interpolated maximum brightness values.

The significance of the equivalent-to-maximum brightness ratio will be apparent when one considers the equation which expresses the relationship of all the factors which affect the source-to-task brightness contrast ratio. This equation, for the diffuse distribution sources which concern us, is:

> Average source-to-task brightness contrast ratio equals the work plain area divided by the product of (1) the source area, (2) the equivalent-to-maximum source brightness ratio, (3) the room interflectance factor, (4) task reflectance.

The practical effectiveness of ceiling diffusers may be demonstrated by the following example. Assume a classroom 30 feet by 30 feet by 10 feet with wall, ceiling and floor reflectances of .50, .75 and .30, respectively, resulting in a room interflectance factor of 0.85 and with a skylight well depth of two feet six inches and reflectance of .80. Also assume a task reflectance of .70, a brightness contrast design limit of 10 to 1 with skylights as the only source and a design illumination level of 35 footcandles with 2000 footcandles on the roof. By substituting the appropriate values in the equation above and solving for source area for a diffuser installation, we find that a source area of 151 square feet or, for example, six diffusers five feet by five feet would be required to meet the brightness contrast limitation. By reference to the afore mentioned paper, after calculating the

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[1]Linforth, E. M.: "Efficiency of Domed Acrylic Skylights," ILLUMINATING ENGINEERING, Vol. LIII, No. 10, p. 544 (October 1958).

net efficiency required to satisfy the illumination specification, it will be found that a combination of W-7328-3/16-inch type domes and W-7328-1/8-inch type ceiling diffusers with a net efficiency factor of .123 will provide almost exactly 35 footcandles.

On the other hand, solving for an installation of exposed W-7508 type domes, for which the equivalent-to-maximum brightness ratio .61 is the most favorable, we find that 248 square feet of skylight area, or six domes approximately five feet by eight feet would be needed. However, the net efficiency of this dome-well combination would be about .063 resulting in an average illumination of only 29 footcandles. To meet the design level it would be necessary to further increase the skylight area to 290 square feet. If, instead, domes of the next higher transmittance were substituted, the increase in brightness contrast would not be significant, but the average illumination under design conditions would become 56 footcandles, an excess of 60 per cent. Under maximum conditions it would be above five times greater which might be acceptable visually but not thermally.

It should be noted that the equivalent-to-maximum brightness ratios used here pertain only to conditions of clear sky and solar elevation of 44 degrees. So far as we know, data are not available to determine these ratios for other angles or sky conditions. However, it may be safely assumed that under overcast sky and at lower sun angles these ratios will increase toward unity for all translucent domes. In view of the fact that the equivalent brightness of W-7 type domes, expressed as a fraction of the illumination on the roof (E_h), remains constant above an angle of about 40 degrees for a given well index and that domes become progressively thinner from flange to zenith, it is equally safe to assume that the ratios will become less favorable as the sun rises above 44 degrees. Therefore, the case for ceiling diffusers is probably stronger than the comparison above suggests.

PHILIP F. O'BRIEN:* I wish to congratulate the authors for an excellent report of another contribution to the experimental study of daylight transfer from the outdoors to the indoors of inhabitable structures.

Although the data presented in this paper amply demonstrate the capacity of the experimental facility to simulate direct sunlight, the numerical information does not completely specify the systems under consideration. For example, the room dimensions, fenestration dimensions, the exact location of instrumentation, the absolute value of sky luminance, the absolute value of direct solar illumination on a plane normal to the sun's rays, the solar elevation, the reflectances of the room surfaces, and many other quantities important to a complete analysis of the data are not given. These detailed data are indispensable for the development of analytical techniques for the study of daylighting. Currently, experimental studies are useful not only to describe specific daylighting systems, but to provide guides to the development of paper and pencil methods of daylighting predetermination. Developments in science and in engineering depend upon the parallel application of experiment and analysis.

*University of California, Los Angeles, Calif.

The problem of uniform flux distribution in the projected beam can be serious as pointed out by the authors in the study of transmission of plastic skylight domes. The uniformity of flux incident from several large projectors on back projection screens such as used on motion picture production stages, has been improved by an ingenious grey filter system. Grey plastic sheet filters arranged in an array about the center of the beam but some distance from the projection lens are cut with scissors and adjusted experimentally until suitable uniformity is obtained. The authors may wish to investigate the applicability of this filter system to their sun-simulator lamp.

BEN H. EVANS AND MATTHEW NOWAK:* Replying to Mr. Griffith's comments, in addition to the sun itself, the area immediately surrounding the sun is of extreme high brightness and has a definite effect upon lighting conditions in our buildings, as Mr. Griffith points out. However, we have not found this to be a problem in studies conducted so far. Mr. Griffith points out that there are three primary sources of illumination for buildings—direct sunlight, skylight, and reflected light from below the horizon. We prefer to assume that the ground conditions, varying from one place to another, are actually part of the building design and should be evaluated along with the building, thereby reducing the sources of light to sun and sky.

Mr. Linforth has stated that ceiling domes and skylight wells have a considerable effect in producing a uniform distribution of brightness on the ceiling dome surfaces. This is quite true. It is possible, with high skylight diffusion, to reduce somewhat the ratio of surface brightness to task illumination. The authors were simply trying to make a point by showing that, roughly speaking, the brightness of the skylight is dependent upon the amount of light passing through. To increase task intensity, it is necessary also to increase skylight brightness.

A diffusing effect which provides uniform distribution and hiding power similar to that of the ceiling diffuser, skylight, and well, can be obtained through the use of a double dome mounted in the roof plane.

It can be simply stated that with today's new materials and design techniques, the cost involved in providing drop ceilings and deep skylight wells is not necessary for effective use of skylights. However, it must be kept in mind that indiscriminate use of dome materials and/or ceiling diffusers will not provide the recommended 70-footcandle level for schools or the corresponding maximum brightness source of 490 footlamberts for the recommended 1:10 brightness ratio. Proper lighting conditions can be achieved only through careful planning by qualified designers.

Complete data are available for all the studies presented in our paper; however, as Mr. O'Brien points out, unless these data are presented, they are of little value to others in the field of daylighting. We will attempt in the future to present the kind of information that Mr. O'Brien seeks.

The suggestion of using plastic cutouts for achieving proper flux distribution from the sunlamp is noteworthy. We have used a similar method and found it to be very helpful, although at a sacrifice of intensity.

*Authors.

NATIONAL ENTRY

CLASS II

Desrochers & Fils Hardware Store

Best Lighting in Town

DEEP IN French Canada, Joliette, Que. (pop. 20,000) had never, until now, experienced the visual pleasure of a really good lighting job. They took it for granted, in rebuilding a store burned out in January 1958, that continuous rows of bare 75-watt tubes would do. This scheme gave an illumination level of about 30 fc, which was comparable to other stores in the locality. Comfort and appearance in the lighting installation were not even considered.

Gerard Denis, up from Montreal, changed not only the store's lighting plan, but the whole town's taste in this direction. Now they *all* want better lighting. The inspiration is Mr. Denis' design for Louis Desrochers et Fils, Ltée., Joliette's largest hardware store.

Mr. Denis' challenge was the introduction of the new IES recommended levels of illumination to new areas. In this case, he was suggesting (against resistance) that the store install more than double the illumination anyone had ever used within a radius of some 50 miles.

As an engineer, another "interesting job" aspect was the rather unusual dimensions of the store. The functional space of the building consists of a main floor at street level and a large mezzanine which leaves an open center of 1800 square feet

Gerard Denis

Montreal Section

Canadian Region

Mr. Denis is with The Shawinigan Water & Power Co., Joliette, Que. This installation won first prize in the Canadian Regional contest for MMILJ.

Illumination Levels

	Average Footcandles
Main Floor	
Open Center	126
On Counter (under mezzanine)	120
Back of Store (under mezzanine)	120
Store Area (under mezzanine)	60
Mezzanine	
Lobby Area	124
Main Office	96
Private Office	60
Storage Area (sides of mezzanine)	55
Stairway (middle)	50
Display (edge of mezzanine)	135
Blue Night Lighting	8

having a ceiling height of 20 feet. As seen from the picture, the store is open front. Customer traffic is on the main floor; back mezzanine area is used for offices; the sides as stock rooms for surplus merchandise. The edge of the mezzanine is also used to display merchandise which can be seen from the main floor.

A complete luminous ceiling was installed for general lighting on the order of 125 footcandles, with incandescent under the outside cornice to avoid contrast with the high levels inside the building. Four-foot and two-foot fluorescent strips are used on 18-inch centers at the open center 20-foot ceiling, and on 24- and 30-inch centers at the far end of the mezzanine where lobby and offices are located. Under the mezzanine, where ceiling height is ten feet, units were spaced on 18- and 24-inch centers. All units are shielded with corrugated plastic sheets four feet wide. Lamps are 40- and 20-watt standard cool white.

Additional "punch" lighting is provided near the window to further attract attention and highlight special displays. Under the outside cornice six 500-watt floodlights are installed to provide the front of the building with enough light to attract passers-by.

This attraction and attention of window shoppers continues after store-closing, through a rather unique use of colored lights. Rows of blue fluorescent tubes are installed in the luminous ceiling between the standard cool white lamps. This provides an unusually beautiful "night sky" effect for the open-front store, and may also be adapted for special lighting effects during the festive holiday seasons.

That Mr. Denis succeeded in his objective—introducing current IES lighting levels to this community—was evidenced immediately. For the 400 people who jammed the store on opening day, the main attraction of the new building was, without doubt, the unusual lighting installation. And the day after the opening, other store owners in the vicinity called for information on better lighting. For what Mr. Desrochers thought, we quote: "I never spent so small an amount of money for the return which I am getting."

I.E.S. Emblem

Official emblem of the Illuminating Engineering Society is available to members in 14-karat gold, lapel screw-back buttons, in miniature ½-inch size at only $3.50, including taxes. Background of emblem is blue for Members, red for Associate Members, white for Fellows. Emblems may be ordered from General Office, IES Headquarters, 1860 Broadway, New York 23, N. Y.

Slow Decay Rates of Phosphors In Fluorescent Lamps

By CHARLES W. JEROME

Most phosphors have been shown to exhibit a two-fold decay. There is a very fast decay which reaches completion in a few microseconds followed by a relatively slow decay. The fast decay is due to the blue color component of fluorescent lamp phosphors and the "per cent flicker" of fluorescent lamps can be used to determine the relative amount of this component in the phosphor. The relatively slow decay in commonly used phosphors is due to the use of manganese as an activator. The rate of decay of the manganese activated phosphors is modified over a considerable range by the crystal matrix making up the phosphor.

STUDIES of phosphor decay rates generally have been made on the phosphors directly[1,2,3,4] and give information useful in a theoretical understanding of the behavior of these materials. The present investigation was carried out on fluorescent lamps, *i.e.*, on phosphors in one of the locales and environments in which they have practical application. In this way, it is hoped to contribute to a clearer understanding of how phosphor decay rate affects lamp behavior.

Most phosphors have been found to exhibit a twofold decay.[2,3] There is a very fast decay which reaches completion in times of the order of a few microseconds, followed by a relatively slow decay. The fast decay is faster than the variation in the electrical supply at all normally encountered frequencies. Therefore, although this decay is also an exponential function, it is so fast that variations in decay rates are masked by the relatively slow variation of the current on a-c operation.

On the other hand, the slow decay components of the phosphors studied are slow compared to the cyclic variation in current on a-c operation and, in the steady state operation of a lamp, only drop off a very few per cent before the rising current on the next half-cycle begins to stimulate the phosphor again.

In this discussion, current has been referred to as though it were the prime cause of fluorescence in these lamps, whereas it is the ultraviolet generated by the current which causes the fluorescence. However, the life of atoms in the excited state is of the order of 10^{-8} seconds.[5] Therefore, the ultraviolet output folows very closely the cyclic variation of the current, and the later is much easier to visualize and measure than the actual ultraviolet emission.

The above discussion indicates that the fast decay component of the phosphors is the determining factor for the flicker found in fluorescent lamps. "Per cent flicker" is derived from the formula:

$$\text{Per cent flicker} = \frac{\text{Max.} - \text{Min.}}{\text{Max.} + \text{Min.}} \times 100$$

Then, from the above discussion, a phosphor, half of whose emission is governed by a fast decay component, and half by a slow decay component, will have a flicker of 33 per cent $\frac{1 - \frac{1}{2}}{1\frac{1}{2}} \times 100$. Similarly, a phosphor which has only a fast decay component will have a flicker of 100 per cent.

Conversely, then the "per cent flicker" of fluorescent lamps can be used as a measure of the relative amounts of fast decay and slow decay components in the phosphor.

In this study, 40-watt fluorescent lamps were operated both on direct and alternating currents. The light output was picked up on a photomultiplier tube corrected to eye sensitivity and presented on an oscilloscope. Pictures were taken of the behavior of the light output when the circuit was interrupted, and from these the decay rates of the phosphors were computed.

In the d-c experiments, the circuit was interrupted by inserting a large resistance (approximately 1000 ohms) into the circuit on a time relay for about 1/10 second. This dropped the light output by approximately 80 per cent, *i.e.*, did not completely extinguish the lamp, but did give a picture of the phosphor decay characteristics. The trace for a standard cool white lamp is shown in Fig. 1. The "instantaneous" initial decay is shown, in this case down to 51 per cent of the steady state value, fol-

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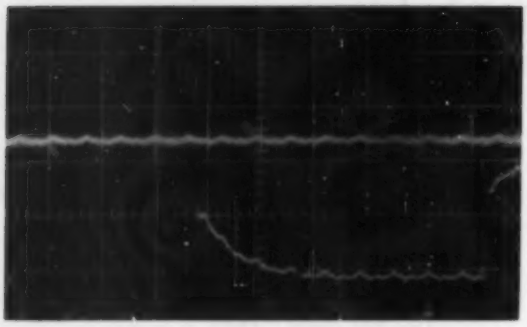

Figure 1. Light output trace of standard cool white 40-watt T12 fluorescent lamp on direct current with insertion of 1000 ohms into circuit for 1/10 second. Heavy line at the top is the steady state light output.

Decay Rates of Phosphors in Fluorescent Lamps.

Color	Per Cent Flicker IES Handbook	Per Cent Flicker Observed	Per Cent Fast Decay	Slow Decay Seconds to Reach .01 I_0	Slow Decay Decay Constant
Standard warm white..	20	17	33	.05	70
White	25	22	36	.05	65
Standard cool white.....	34	31	48	.05	61
Daylight	50	53	70	.06	65
Warm white deluxe	20	23	37	.075	39
Cool white deluxe	34	38	54	.045	46
Soft white	30	46	63	.05	33
Super deluxe	—	91	95	—	—
Calcium silicate (Pb, Mn)	—	17	29	.10	33
Cadmium borate (Mn)..	—	24	39	.075	72
Zinc silicate (Mn)	—	26	41	.0075	215
Magnesium tunstate	—	100	100	—	—
Barium silicate (Pb)....	—	100	100		
Calcium tungstate (Pb)	—	100	100		
Barium titanium phosphate	—	100	100		
Calcium-zinc phosphate (Sn)	—	100	100		

lowed by the slow decay for the balance of the light decay.

This picture also shows what happens to the light output when the resistance is removed from the circuit. It is interesting to note that this behavior is qualitatively identical, in reverse, to the decay portion of the curve. That is, there is an initial rapid rise in output, followed by a slow recovery back to the original intensity. Other traces corroborate that it is the phosphor component that undergoes the rapid decay that is also responsible for the rapid recovery. In other words, the characteristics of the phosphor which determine its decay rates also determine the build-up of its emission. A long afterglow (slow decay) of a phosphor is usually attributed to the slow emptying of electron traps. The above observation indicates that upon reactivation, these traps must be refilled before full emission is resumed. A priori, the rate of the recovery depends on the concentration of ultraviolet in the arc, whereas the decay is a function of the phosphor alone. If this is true, then high-output lamps should have a faster recovery than the standard ones because of the higher concentration of ultraviolet available. But both should have the same decay characteristics. However, this is beyond the scope of the present paper.

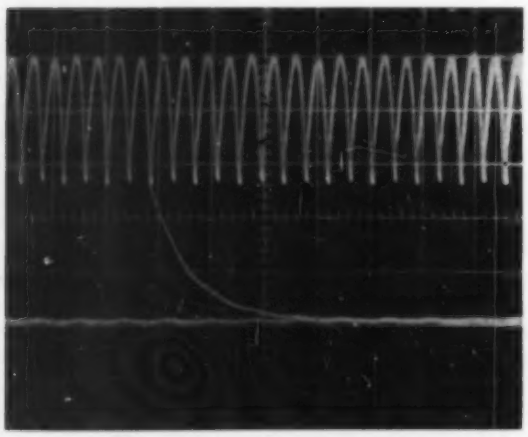

Figure 2. Light output trace of standard cool white 40-watt fluorescent lamp on alternating current when circuit is opened. Horizontal line in lower portion is the zero output line.

Fig. 2 shows traces of the light output of the same lamp operated on a-c. In this case, the decay trace was obtained by completely opening the circuit, *i.e.*, the light was allowed to decay to zero. The cyclic variation in light output during the steady state operation on a-c is clearly shown. The relative magnitude of this variation compared to the total light output, is found to be equal to the relative magnitude of the "instantaneous" decay in the d-c experiment shown in Fig. 1. Therefore, in this study, the "per cent flicker" on a-c operation has been used as the measure of the relative proportions of the fast and slow decay components and is the source of the data in the column, "Per Cent Fast Decay" in the table. Corroborating evidence is supplied by the d-c measurements. However, the latter experiments were not used for this fundamental measurement because of the difficulty in determining the point of demarcation between the two types.

Similar curves for the other phosphors were obtained. These curves differ mainly in the relative amount of the fast decay component and slightly in the decay rate of the slow component. Figs. 3 and 4 show the experimental curves for calcium silicate (Pb, Mn), the phosphor with the lowest fast decay component of those studied. Figs. 5 and 6 show the corresponding curves for magnesium tungstate, typical of phosphors with no slow decay component.

The observation that the fast decay component

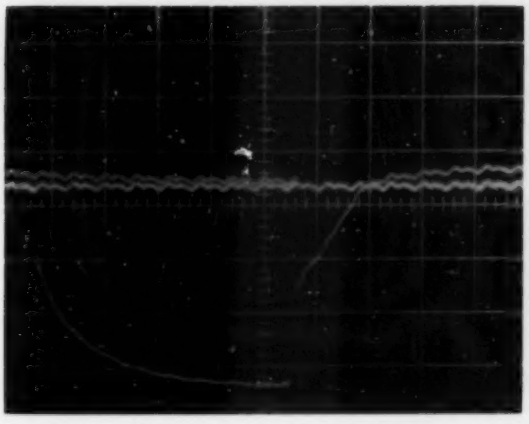

Figure 3. D-c light trace for calcium silicate (Pb, Mn).

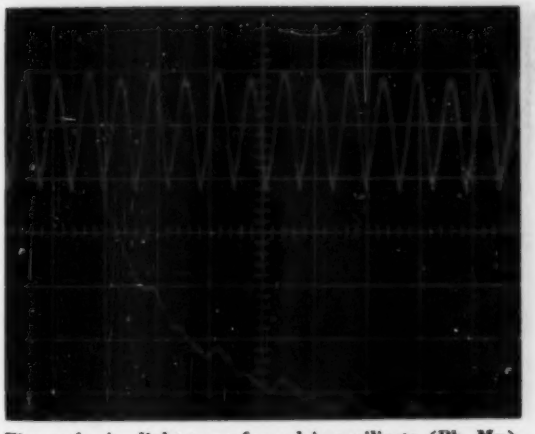

Figure 4. A-c light trace for calcium silicate (Pb, Mn).

gave rise to flicker in these lamps suggested that the "per cent flicker" should remain the same up to frequencies where the supply voltage varied at speeds comparable to the decay rate of the fast component. Fig. 7 shows the a-c curves for standard cool white at 400 cycles. The "per cent flicker" determined from these curves was 31 per cent, *i.e.*, the same as at 60 cycles, thereby confirming the above conclusion. Data in the literature on the decay rates of the fast components indicate that frequencies of the order of magnitude of 100,000 cps are necessary before the fast decay is overcome and the "per cent flicker" will be reduced by the speed of the voltage variation.

These measurements indicate that in most cases the rapid decay component of the phosphor is the blue color component. This is shown partially by the increase in "per cent flicker" as the standard colors progress from warm white to daylight, *i.e.*, with increasing blue component. This was also corroborated by measurements on various blue phosphors including blue halophosphate, all of which gave 100 per cent flicker, as shown in Figs. 5 and 6 for magnesium tungstate.

The fast decay component of the calcium silicate (Pb, Mn) can be attributed to the near ultraviolet band in the emission of this phosphor. Similarly, the color of the zinc ortho silicate (Mn) (green) is approximately midway between red and blue, which may explain its intermediate percentage of fast decay. However, the fast decay component of cadmium borate (Mn) remains as an exception to this simplified explanation.

From these pictures, the slow decay of the phosphor was analyzed by finding the decay constant, for the various phosphors. This was done by finding the exponential equation: $I/I_o = e^{-kt}$ which best fitted the observed data for the slow decay portion. In this equation, k = the "decay constant," t = time in seconds, and I_o is the intensity after the fast decay has reached completion. These values, together with the flicker information, are listed in the table.

Fig. 8 shows the correlation between the theo-

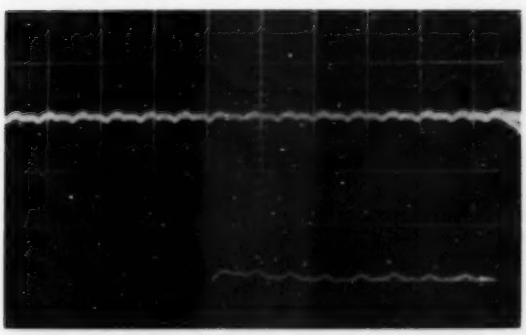

Figure 5. D-c light trace for magnesium tungstate.

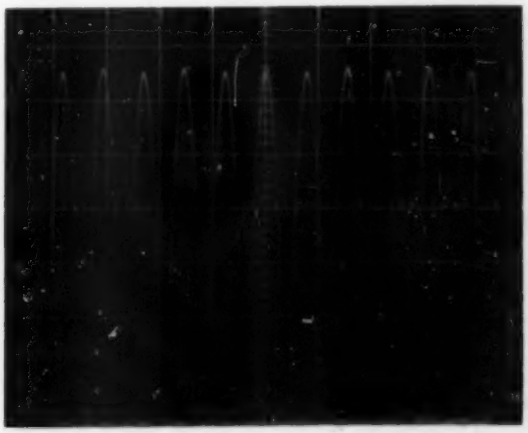

Figure 6. A-c light trace for magnesium tungstate.

Figure 7. A-c light trace for standard cool white lamp at 400 cps.

retical decay curve for white and the observed values. Fig. 9 is a similar presentation of the data for warm white deluxe.

In the table, the "per cent flicker" for those of these lamps which are given in the Third Edition of the *IES Lighting Handbook* are also listed. These show a fair degree of agreement. For the most part, the slight variations can be explained on the basis of different production and processing techniques of the several lamp manufacturers. The large discrepancy in the soft white values is due to a color difference. Several years ago some of the lamp manufacturers changed the color of this lamp toward the red and the flicker listed in the *Handbook* is for this new color. Our company retained the old color and in view of the above discussion on the relative flicker of the bluer phosphors, it is to be expected that the value obtained in this study would be higher.

In all these phosphors, the red emission band, and therefore the slow decay component whose decay constant is listed in the table, owes its color to the use of manganese as the activator. It is concluded that the different decay rates are therefore due to modifying effects of the crystal matrices of the different types of phosphor. For example:

In calcium halophosphate (standard colors)	$k_{Mn} \sim 65$
In calcium silicate (deluxe colors and Soft White)	$k_{Mn} \sim 40$
In zinc O-silicate (green)	$k_{Mn} \sim 215$
In cadmium borate (pink)	$k_{Mn} \sim 70$

The value of 65 for k_{Mn}, shown for the calcium halophosphates above, is probably the value for all the standard colors. The spread of values shown in the table is attributed to experimental error in these determinations. Similarly, the value of 40 for the deluxe colors and soft white is the most probable value for these phosphors. In Figs. 8 and 9 a vertical line at .02 seconds indicates the spread corresponding to the range of k values given in the table.

In summation, this study has indicated that the rapid decay component of fluorescent lamp phosphors is the principal cause of flicker in these lamps on a-c operation; that the blue phosphors have only a very rapid decay giving rise to 100 per cent flicker; and that the decay rate of manganese is modified over a considerable range by the crystal matrix making up the phosphor.

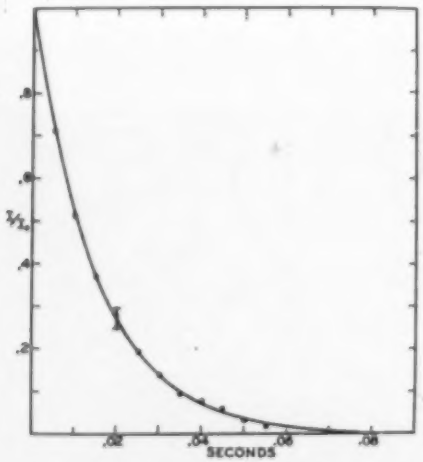

Figure 8. Decay curve, $I/I_0 = e^{-65t}$. Open circles—observed points for white fluorescent lamp. The vertical line at 0.02 second indicates the spread caused by decay constants from 61 to sec^{-1} to 70 sec^{-1}.

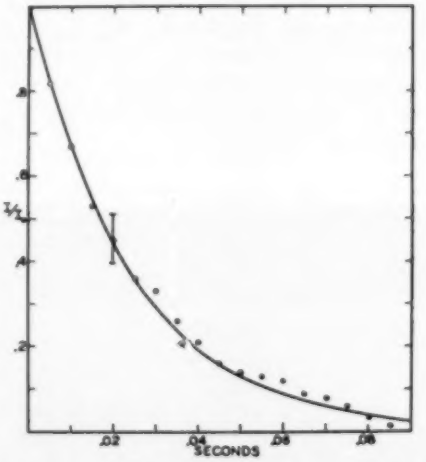

Figure 9. Decay curve, $I/I = e^{-40t}$. Open circles—observed points for warm white deluxe fluorescent lamp. The vertical line at 0.02 second indicates the spread caused by decay constants from 33 sec^{-1} to 46 sec^{-1}.

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DISCUSSION

E. F. KELLEY:* This paper explains the phenomenon which causes lamp flicker and provides a stepping stone for further development and possible improvement in phosphors for fluorescent lamps. I compliment the author on his approach to the problem and his detailed study.

It is not generally realized that there is a fast and a slow decay component in most phosphors. The author points out that the exception to this is the blue phosphor, regardless of its chemical composition. Among the several blue phosphors of different chemical make-up listed, is there an explanation for the fact that they all have 100 per cent fast decay and flicker?

The exponential equation $I/I_o = e^{-kt}$ that determines the slow decay constant needs clarification. I is not defined, and without reference to Figs. 8 and 9 could easily be misunderstood.

With the advent of improved phosphor treatment from preparation through lamp making, uniform particle size is closely controlled. Is it possible that this will influence the decay rate?

The author ties in the slow decay component with the use of manganese as the activator and in conclusion claims the decay rate of manganese is modified over a considerable range by the crystal matrix making up the phosphor. Considerable experimentation has been performed using other metallic activators with combinations of the same. Has any other activator or combination of activators shown promise as a substitute to improve the decay rate but maintain color and brightness?

H. C. FROELICH:** Periodically, the question of flicker of fluorescent lamps is brought up by illuminating engineers who will, therefore, welcome a new discussion of the subject. For practical applications, however, the important characteristic to consider is not the "per cent flicker" as determined physically on single lamps, but the "flicker index" which relates lamp flicker with the responsiveness of the human eye. This was pointed out by Eastman and Campbell[1] several years ago. These authors also described the method of determining per cent flicker (and the flicker index) which is used in the present paper. Caution is therefore advised against applying the per cent flicker data directly to practical lighting installations, especially those involving multiple lamp operation.

As Mr. Jerome points out, the flicker of fluorescent lamps depends largely upon the nature of the phosphors used. Lamp colors such as those generally designated as "deluxe" or "soft white" are being produced with a number of diverse phosphors of different decay characteristics, depending upon the manufacturers' best judgment. Hence, it becomes necessary to clearly specify the components of the blends to which definite numbers are assigned for their flicker or fast decay. Lighting engineers are mostly interested in the various shades of white lamps and will welcome information on the newer ones. It is, therefore, suggested that the information on the phosphor components used in the different blends be added to the table. The same comment, incidentally, applies to a future edition of the *IES Lighting Handbook*.

The term "slow decay" appears to be a somewhat unfortunate choice. It can be misinterpreted too easily by many lighting engineers who will associate with it the long and slow phosphorescence which one observes in the dark after fluorescent lamps have been turned off. The long-glowing orange light emitted by deluxe or soft white lamps containing calcium silicate phosphors is a case in point. The data shown in the present paper do *not* refer to this truly slow decay which is of low brightness and does not follow an exponential decay law. This slow decay, of course, does not affect the flicker of fluorescent lamps.

1. Eastman, A. A. and Campbell, J. H.: "Stroboscopic and Flicker Effects from Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. XLVII, No. 1, pp. 27-35 (January 1952).

C. W. JEROME:* The answer to Mr. Kelley's question regarding blue phosphors is the absence of manganese. As indicated in the paper, the slow decay component in all the phosphors tested here has manganese as the activator. Its absence in the blue phosphors, therefore, leaves them with no slow decay component.

In the decay equation, $I/I_o = e^{-kt}$, I is the instantaneous value of the intensity at the time, t. The other quantities in the equation are as indicated in the paper.

I do not believe the control of particle size will have any effect on decay rates. The decay is associated with the activator and regardless of the particle size, the activator should be dispersed uniformly through the crystal matrix, resulting in the same decay characteristics for all particle size ranges.

Manganese appears to be unique in fluorescent lamp phosphors. To date, no other activator has been encountered with better decay characteristics.

Dr. Froelich's comments regarding "per cent flicker" and "flicker index" are pertinent. In this study, however, flicker was of secondary importance and was only used as a measure of the relative amount of the rapid decay component in each of the phosphor systems. For this purpose, "per cent flicker" gave the required information, whereas, "flicker index" would not have done so. In the table, "per cent flicker" was listed only because it was determined and was interesting supplementary information.

The "deluxe" and "soft white" blends used in the study were those of long standing—calcium silicate (PbMn) as the red component; magnesium tungstate as the blue component and zinc silicate (Mn) as the green component.

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**General Electric Co., Lamp Division, Cleveland, Ohio.

Address Changes

Any change in address should be reported to John K. Michel, Membership Secretary at IES Headquarters, 1860 Broadway, New York 23, N. Y., by the first of any month to insure uninterrupted mailing of ILLUMINATING ENGINEERING and other Society communications.

Model Office Lighting

QUALITY high-level lighting installations in the model offices of the newly-constructed Logan Building in Seattle, Washington, were one of the factors responsible for almost complete renting of the building prior to the completion of construction. This is the opinion of the renting agents for the 11-story office building, now avid proponents of good lighting.

The illumination system installed throughout the building uses large area recessed luminaires equipped with F40T12-3 lamps, rated at 3100 lumens. (These new lamps, incidentally, can be used not only in installations designed with them, but as replacements in installations with rapid-start ballasts or preheat ballasts and FS-400 starters.) Maintained lighting level for the model offices shown here are 260 (photo at top) and 120 footcandles. Provisions have been made for installation of additional fixtures in the second office to raise the lighting level, if desired.

Comfort and quality were engineered into these model offices with the use of light surfaces throughout—ceilings, walls, floors and desk surfaces. Here, on display, is a "good lighting practice guide" for future tenants.

Mandeville & Burge were architects and engineers for the Logan Building, with Emery Roth & Sons serving as consulting architects.

Large area recessed fixtures with F40T12-3 lamps produce a comfortable 120 footcandles for performance of office tasks.

Development and Use of a Quantitative Method for

Specification of Interior Illumination Levels On the Basis of Performance Data

(Discussion and rebuttal of a paper by H. Richard Blackwell Published in June Illuminating Engineering)

DOMINA EBERLE SPENCER:* The general method of approach (to specification of interior illumination levels) suggested by Dr. Blackwell is good. However, before the IES extends its official approval to the method and places its faith in recommendations based upon it, certain basic questions should be answered.

First is the question: what are the *basic experimental* data on which the entire method rests? Dr. Blackwell and his colleagues have obtained data on the minimum perceptible contrast as a function of the brightness of the background for various exposure times and for test spots of various sizes. But Dr. Blackwell has not given IES members the opportunity to examine the actual data until the final published version of the paper (in June 1959). Instead, he previously published several sets of smoothed curves. Not even the most recent smoothed curves form a consistent family. Before the experimental data were available we had no opportunity to judge whether the unbelievable meanderings of his curves were significant or merely the result of some graduate student's lack of experience in curve fitting. Dr. Blackwell says his curves form a consistent family. But the curves he employs do not. The Society should determine whether the data can be fitted by a suitable family of analytic curves within experimental accuracy. It should not accept a meandering family of curves without determining for itself whether the irregularities are required by the data. The fact that the Blackwell data are now published for the first time raises the important question of when a complete analysis of the data can be made and reported to the Society.

Another question concerns the extrapolation of the S-curves to 99 per cent. As no experimental data are taken at the 99 per cent level this procedure is questionable.

Once the questions related to the experimental data are settled, a major question remains. It is proposed to formulate recommendations on quantity of light, quite independently of the brightness distribution in the field of view. This procedure is unsatisfactory, for non-uniformity in the surround affects both the state of adaptation of the eye and the appearance of any task which is not perfectly diffusing. Even for perfectly diffusing tasks, specification of quantity of light independently of the distribution in the surround is visually meaningless. If there are bright light sources in the periphery of the field of view, the state of adaptation will be altered and minimum perceptible contrast thresholds will be raised. Specular tasks are even more sensitive to the brightness distribution in the surround as their entire appearance is altered if specular reflections of light sources occur.

Some years ago I had the honor of being a member of a Committee in the State of Massachusetts, under the Chairmanship of R. B. Brown. For our State, we abolished mandatory lighting codes which required specific quantities of light. We deemed this progress, for we sincerely believed that specification of quantity without specification of quality is visually meaningless. Now the IES appears to be on the verge of taking a major step backwards by laying down recommendations on quantity of light independent of quality.

The case for neglecting quality is especially poor as a method of taking it into account lies ready for use (See Chapter VIII, Moon and Spencer, *Lighting Design*, Addison-Wesley Press, 1948). If the Society leaps to embrace a new set of recommendations on quantity independently of quality it will not enhance its reputation as a scientific organization.

R. G. HOPKINSON:* I will support Dr. Spencer in what I understand was a request for more detailed knowledge of the variance in the visual ability of the population with which we are dealing. If we are concerned with codes of lighting practice we need this knowledge just as we need to know the variance in the sensitivity to glare of our population. This request is not a criticism of the brilliant work which has gone into the execution of the experiments on the fundamental contrast data—for this I have nothing but admiration.

I am less happy about the evaluation of these data in terms of actual visual tasks. I would like to understand more about this in case I comment too dogmatically, but I have never been happy with objective measures of supra-threshold visibility which employ artificial attenuation of the task to threshold. Many of these devices—visibility "meters" of different kinds, exist solely because we are scared of believing what people tell us of what they see. Yet all these "meters" suffer from basic faults, sometimes negligible but often gross, which may well introduce errors as great as those we seek to eliminate in our repudiation of a subjective appraisal. Apart from Dunbar's classic examination of the claims of threshold type devices, my qualms are based on a series of war-time studies which I did of comparisons between the readings of various types or threshold visibility meters (contrast reduction, brightness attenuation and combinations of both) and subjective appraisals of visibility of various displays. While the meters at their best could give a close approximation to the subjective evaluation of simple displays, they often failed completely to give guidance on tasks which required higher visual skill, and it needed a detailed knowledge of the nature of the visual task to be able to predict when they would break down. Consequently I would be much happier if Dr. Blackwell had not used a reduction-to-threshold method in his visual task evaluator. I believe that, with experience, skilled observers are able directly to evaluate actual tasks on a multiple-criterion scale with useful precision. Their findings can be checked back to the basic contrast data when necessary.

Dr. Blackwell is a considerate man and will forgive those of us who have had difficulty in following through his train of reasoning. I had understood that his main criticism of the British IES Code is that it is based on Weston's experiment which was "response limited." I had always understood, however, that Weston's method of analysis of his data eliminated the response terms and evaluated only the periods occupied in performance of the purely visual task. This criticism in any case cannot extend to Beuttell's original concept of the analytical breakdown of the visual task into its components of contrast and critical detail, which was the real starting point for the British work.

If this is accepted, it then appears that we have to choose between Weston's type of experiment, which is response limited but is sufficiently close to com-

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mon sense seeing not to require the insertion of any field factors, and Dr. Blackwell's type of experiment, which eliminates one set of errors but which results in such acute seeing that arbitrary compensating field factors have to be introduced to bring it into line with common sense seeing, and the whole result then checked with a visual task evaluator. I do wonder if we really would go so seriously astray if we obtained direct subjective appraisals of ease of seeing by means of a carefully-designed multiple-criterion experiment.

GLENN A. FRY:* Dr. Blackwell's method of evaluating quantity of illumination required for a task represents a definite advance over the methods now recommended by the Illuminating Engineering Society. In the old method, visibility was evaluated by changing the level of illuminance, whereas in Dr. Blackwell's method, changing contrast is used for this purpose. Another feature of Dr. Blackwell's method is that it has incorporated data obtained with the device which he has called the visual task simulator which helps to bridge the gap between simple visibility data and visual performance.

I want to take this opportunity to pay a tribute to the role which Professor Strong has played in this development as a member of the Technical Advisory Committee of the Illuminating Engineering Research Institute. Dr. Blackwell's method represents a distinct departure from old methods and in the early days a good many of us were skeptical about switching to a new direction. Professor Strong's foresight and enthusiasm have done much to encourage this development.

WARD HARRISON:** With the publication of the June 1959 issue of ILLUMINATING ENGINEERING, we now have the complete reports by Dr. Blackwell of what our Society terms "a scientific basis for valid recommendations of illumination levels." I have studied this latest report, also those of 1952 and 1955, and Crouch's 1958 summary. Taken together, these publications give one every reason for confidence in the actual measurements taken by Dr. Blackwell and his observers. They do, however, raise many questions regarding the methods by which these laboratory measurements have been adapted to practical conditions and the degree of precision that can be expected from these adaptations.

(1) For a certain seeing condition, time 1/3 second, contrast .5, size 4 minutes of arc and 99 per cent accuracy, Crouch's chart on page 419 (IE, August 1958) calls for 1000 footlamberts as a practical lighting recommendation. Figs. 3 and 4 of Blackwell's 1952 Report show that his trained observers required about 0.3 footlamberts for this same task; that is, the ratio is 3000 to 1 between laboratory measurements by skilled observers and the recommended value. The question arises, with a factor of this magnitude, how can one justify such precise recommendations as 3140 footcandles for task 10; or 1890 footcandles for task 28; or 487 footcandles for task 34. (See page 423, IE, August, 1958.)

(2) For a certain condition (.95 contrast chart, page 419) 10 footlamberts is called for. Skilled observers required less than 0.1 footlambert. This is a factor of 100 to 1. Similarly, where the recommended value is 100, the measured observation was less than 0.1 footlambert, a factor of 1000 to 1; and, as stated previously, where 1000 footlamberts are called for, the observers required about .3 footlambert, a factor of 3000 to 1. The question arises—are all these various factors established on an adequate scientific basis? The answer is that they are all based on a "field factor" (FF) of 15. This does not mean that the illumination should be 15 times the laboratory values but rather that footcandles must be provided that would enable observers in the laboratory to distinguish contrasts 1/15 as great as that of the actual task. This may mean footlambert values 100 to 1000 times as great.

It appears from the reports that the field factor of 15 may be subdivided about as follows:

1.2—for the lesser accuracy of a "yes or no" method versus the "forced choice" method used in the laboratory (measured and no doubt valid).

2.0—for the difference between highly skilled laboratory workers and "naive" observers.

4.0—the difference between seeing an object in the "center of fixation" and one 2 degrees off axis.

1.5-1.8—for lack of knowledge of when and where the test object will appear.

$1.2 \times 2.0 \times 4.0 = 1.5 = 15$. Each of these four factors requires the most careful scrutiny for they have tremendous leverage where the illumination values are high. For example, where 1000 footlamberts is called for, the factor of (2), if it could be eliminated, would reduce the requirement to 5 footcandles. Is it not true that one who has devoted months or perhaps years to the "inspection of white handkerchiefs for rolled edge defects" (task 52) may become just as expert at that task as the laboratory girls are in detecting their circular targets? Certainly, they are not "naive observers" and at least they should require a factor very much less than the (2) which has been assigned to everybody. Very likely, they can see perfectly well with much less than 3300 footcandles mentioned for them.

$4 \times 1.5 = 6$. Dr. Blackwell's tests on the Field Task Simulator are convincing as to the increased contrasts of 6 to 7 to 1, which are required to detect moving targets in comparison with stationary ones in the laboratory; hence, it strongly suggests that the factor of (4), to cover vision at 2 degrees off axis, is necessary with moving targets. However, this does not prove that the same factor is needed when viewing stationary objects; rather, it suggests that a much smaller angle should be sufficient; calling for angle of 1.50 degrees would reduce the multiplier of (4) to (2.57) and reduce a 1000-footlambert requirement to about 25 footlamberts or a 100-footlambert requirement to about 8 footlamberts. Dr. Blackwell indicates (top of page 346—IE June 1959, second column) that this is very likely true.

1.5 This multiplier applies to circumstances in which the "when" and "where" are not known and should be eliminated entirely for reading and similar tasks. I believe Dr. Blackwell subscribes to this.

(3) All of the foregoing discussion has been based on an FF of 15 which is the only value mentioned in Mr. Crouch's summary. It has also been based on a visual capacity of 5 APS, that is, upon a single item of information being assimilated at each fixational pause of the eyes, usually about 1/5 of a second. Perhaps as a result of criticism of a field factor of 15, as applied to stationary objects such as printed words, Dr. Blackwell has set up an FF of 10 for such tasks. This change taken alone would have reduced the requirement for sixth-grade pencil writing (task 2) from 63 footcandles to perhaps 6 footcandles. However, Dr. Blackwell now believes that the child should be enabled to assimilate three items of information at each fixational pause, instead of one item, and this brings the required value back to about where it was before. Two questions which this latter proposal raises are:

How do we know that assimilating 3 items of information in 1/5 of a second requires the same amount of light as to assimilate one item in 1/15 of a second, which latter he has measured?

How do we know that a sixth-grade pupil, when writing, needs to assimilate more than 5 items per second; if so, why not 10 items rather than 15?

(4) To summarize, I have the maximum of confidence in the actual measurements obtained by Dr. Blackwell and I am very impressed with his breaking down of the "process of seeing" in terms of contrast field factors and assimilation per second. It must not be

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overlooked, however, that the field factors and the APS chosen, all in round numbers, rather than the laboratory measurements have the overwhelming influence in arriving at the very high footcandle values that he proposes for some tasks. It would seem that these multipliers require much more research to back them up in advance of their official adoption. On the other hand I can subscribe wholeheartedly to the majority of footcandle values in the new IES recommendations.

H. RICHARD BLACKWELL:* First, let me say that I am honored that my paper has elicited thoughtful discussion by so many intellectual leaders in the Society.

To simplify my rebuttal, I will comment on the questions raised by the various discussers in terms of the aspect of the paper to which the questions refer. To facilitate this, I will first review the salient features of the paper.

(*a*) An analysis of visual performance in terms of accuracy, levels of visual capacity (including the number of items of information per fixational pause, information limitations and response limitations), and the conditions of performance (including extent to which ocular searching and tracking are involved and knowledge as to where, when and what is to be seen).

(*b*) Collection of visual performance data for different accuracy levels, levels of visual capacity and different conditions of performance for standard tasks of varying difficulty.

(*c*) Selection of suitable accuracy levels, levels of visual capacity and conditions of performance to be provided by lighting.

(*d*) Evaluation of the difficulty of various practical tasks in terms of the standard tasks for which performance data exist.

I will first discuss the general comments on the paper and then consider comments pertaining to each individual aspect of the method.

Dr. Hopkinson alone of the discussers has criticized the general method, suggesting that the Weston method may be preferable. In terms of the analysis of my method into four aspects, Weston's method can be seen to consist principally of collection of performance data for standard tasks (Landolt rings) of varying difficulty which have a fixed information limitation, fixed response limitation and fixed condition of performance. Performance indices include accuracy and number of items covered per unit of time. The Weston method is valuable but simply incomplete. It forces us to consider all tasks as similar to Weston's task with respect to information limitation, response limitation and the conditions of performance. I am particularly unhappy about the atypical response limitation involved in Weston's task which is not corrected for by the method of data analysis, as Fry has recently shown in an unpublished manuscript. Weston's method does provide for selection of a performance index or indices to be provided by lighting. It does not provide a satisfactory method of evaluating difficulty of various practical tasks, since measurement of critical detail of a task is inadequate.

The Beuttell method to which Hopkinson refers has not been an integral part of the Weston method, nor do I believe, a reasonable assessment of the difficulty of practical tasks can be made by analysis of task size and contrast. Thus, in my opinion, the British do not have a complete method to substitute for mine. The Dutch and Russian workers in this field seem to agree that a method with all the components of mine is required. So, the British seem to be "odd man out" on this one.

Dr. Spencer has criticized the wisdom of the IES in using my paper as a basis for lighting recommendations and, indeed, in recommending levels of lighting at all. This criticism is not properly directed at my paper and I will refrain from comment on it.

Dr. Spencer has also questioned the applicability of the method to environments of non-uniform luminance. In the paper, I describe the general method for allowing for direct disability glare and for reflected glare. In each case, physical measurements of the glare produced by a given non-uniform environment are required. We are currently developing instruments to use in making these physical measurements.

Aspect (*a*)—There appear to be no unfavorable comments about my analysis of visual performance.

Aspect (*b*)—Dr. Spencer has attacked my visual performance data strongly. She reports that my raw data are unavailable and my curve fits "unbelievable." As to the first criticism, tables of all raw data from the original studies were mailed to her on February 2, 1959, and raw data for the additional studies are presented in full in the published paper.

As to her second criticism, I point out in the paper that curves relating log C to log B need not be "smooth" and, in fact, cannot be smooth if basic visual variables operate as all existing data suggest they do. Our curve fitting was performed with scrupulous care by expert mathematicians in a manner described completely in papers sent to Dr. Spencer.

Dr. Spencer has also criticized the "extrapolation" to 99 per cent accuracy. She is incorrect in stating that we always require extrapolation to reach this level of accuracy, since we often have actual accuracy data at 100 per cent. In the cases where extrapolation is needed, we utilize the normal frequency function which experiments have shown adequately fits all our data points.

Dr. Harrison has suggested that we do not have data for the 3 APS-level, but, of course, we have as much data at that level as at the 5 APS-level, so the criticism is unwarranted.

Dr. Hopkinson has inquired about the variance of the performance data, a reasonable request indeed. I agree with his implication that we should have performance data on more observers. In fact, I have long since proposed to IERI that such a study be conducted.

Aspect (*c*)—Dr. Harrison has questioned my selection of a 5 APS-level of visual capacity and a field factor of 15 to allow for conditions of performance, by describing tasks for which these constants do not seem appropriate. I agree that such tasks can be found. In fact, it was largely because of the excellence of Dr. Harrison's argument that I presented curves for different field factors and different capacity levels in the paper. The single values of capacity level and field factor were chosen to be representative of all tasks, *on the average*. Eventually, we will develop methods to use different appropriate levels of visual capacity and different field factors for various tasks. I have proposed to the Illuminating Engineering Research Institute that studies be made, as soon as possible, to develop such methods. Dr. Harrison is correct that the selection of these constants is very important. It is precisely for this reason that I do not favor the Weston method which can never assign different field factors to different tasks.

Aspect (*d*)—Dr. Hopkinson criticizes the procedure used in my method to evaluate the difficulty of practical visual tasks. He expresses faith in a direct subjective assessment of task difficulty with a multiple criterion method. Presumably, this method would have to be used with standard tasks as well, since comparative data will be required in any method utilizing performance data for standard tasks. I believe that the psychometric procedure Hopkinson proposes would be clumsy and extremely time-consuming. However, since no one has actually tried such a method, it is not possible to evaluate this suggestion critically. I must say I am not enthusiastic, but if Dr. Hopkinson could demonstrate the advantage of this method, it can be substituted for my procedure of visual task evaluation.

*Author.

I.E.S. Guide to

Design of Light Control

Part II—Design of Reflector and Optical Elements

Prepared by the Committee on Light Control and Equipment Design of the Illuminating Engineering Society

1. Introduction

This part of the Guide* deals with fundamentals usually employed in the design of reflector contours, optical refraction and lamp concealment by shielding.

2. Reflector Control

(a) The design of reflector contour is an extensive subject. Possible shapes which might have a use for a particular application are almost limitless. There are, however, a few commonly used contours that can be designed from elementary principles.

(b) For design purposes reflector contours can be divided into two classes, basic contours and general contours. Basic contours may be defined as those which are mathematically predictable as to action and can be designed mathematically. General contours are those required to satisfy many candlepower distribution curves, but which do not conform to any of the basic contours.

2.1—*Basic Reflector Contours*—(a) A few basic contours which are used very frequently are the conic sections and the spherical reflector.

(b) A conic section is by definition the locus of a point whose distance from a fixed point is in a constant ratio to its distance from a fixed straight line. The fixed point is called the focus of the conic section; the fixed line is its directrix. The constant ratio is the eccentricity of the conic section. If the eccentricity, e, of the conic section is equal to one, the section is called a parabola; if e is less than one, an ellipse. A third conic section, the hyperbola occurs when e is greater than one.

Figure II-1. Conic sections formed by a plane and a cone of revolution. *a.* Parabola, plane parallel to face. *b.* Hyperbola, plane parallel to axes. *c.* Ellipse, plane not parallel to base, axis or face.

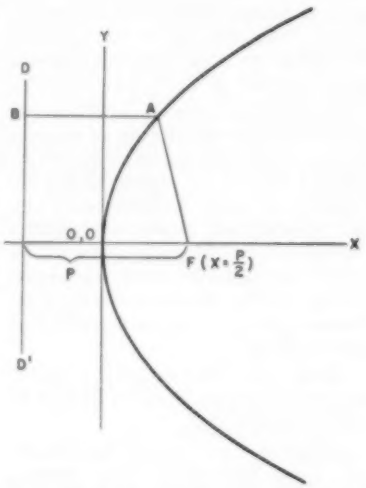


Figure II-2. Any point on a parabolic curve is equidistant from the focus and the directrix, $FA = AB$.

(c) Another way of defining these conic sections would be as the intersection of a plane and a cone of revolution (Fig. II-1).

2.1.1—*Parabolic Reflectors*—(a) Parabolic reflectors are used in light control to produce beams of essentially parallel light rays.

(b) The parabola, when drawn on rectangular coordinates, can be expressed by the equation $y^2 = 2Px$, where P is the distance from focus (F) to directrix (D-D'). This assumes a parabola open to the right with the vertex at the origin 0,0, (Fig. II-2). Any point on the curve would be equidistant from focus F (at $x = P/2$) and the directrix (line D-D'), so that regardless of the locaton of point A, distance FA is equal to distance AB.

(c) To the lighting engineer, the interesting feature of the parabola is its ability to redirect a ray of light originating at the focal point in a direction parallel to its axis. This is due to an inherent property of the parabola—that a tangent drawn to any point on the curve will bisect the angle formed by the focal radius drawn to the point of tangency and a perpendicular line from the directrix to the point, as shown in Fig. II-3. With a ray of light as the focal radius, the redirected ray will be parallel to the axis since the angle of incidence (to the tangent) must equal the angle of reflection (to the tangent), that is angle FAA' equals angle $B'AA''$ in Fig. II-3. Assuming a point source at the focus and a perfect mirror, all light from the source strik-

Errata

Design of Light Control—Part I, page 724, November IE.

Section 5.3 (b), line 8, $n_1 < n_2$ should be $n_1 > n_2$.

*Part I—Physical Principles appears in the November, 1959 issue of ILLUMINATING ENGINEERING, pp. 722-727.

Approved by the Council of the Illuminating Engineering Society, July 1958. A Transaction of the Society.

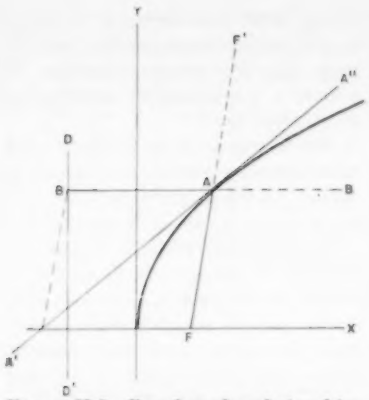


Figure II-3. Equal angle relationships of a parabola. Angle BAA' = angle FAA'. Angle $F'AA''$ = angle $B'AA''$. Angle FAA' = angle $B'AA''$.

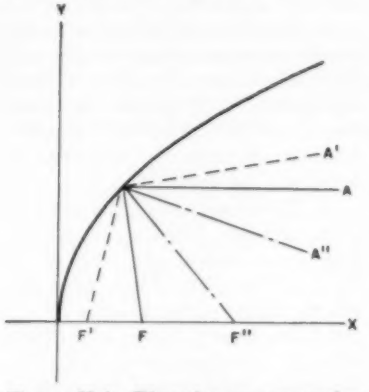


Figure II-4. Diverging or converging rays from point sources on the axis of a parabolic reflector behind and ahead of the focal point.

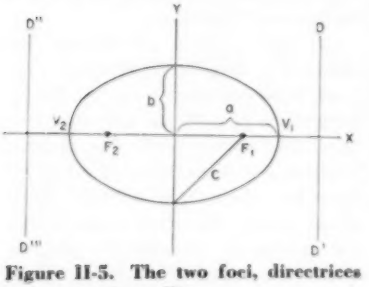


Figure II-5. The two foci, directrices and axes of an ellipse.

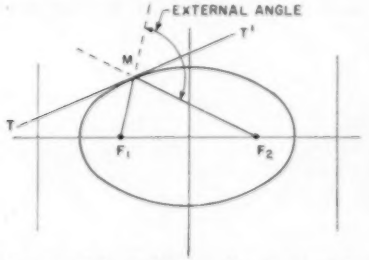


Figure II-6. Relation of a tangent to the focal radii of an ellipse.

ing the mirror would be redirected as a beam of light parallel to the axis. The reverse principle is also useful, where a parabolic mirror is used to concentrate parallel rays of light at the focus of the parabola.

(d) The ideal conditions of the perfect mirror and the point source cannot be reached in practice, nor, in most cases, would this be desirable. The further conditions deviate from the ideal, the greater will be the deviation from the perfect parallel beam of light emerging from the mirror. Calculations of beam divergence have been extensively studied and formulas have been derived expressing the divergence from shallow mirrors using variations in source, such as: axial lineal filaments, ring filaments, v-shaped, conical and acylindrical spiral filaments.[1] The derivation and applications of these expressions, however, are beyond the scope of this work. Fig. II-4 illustrates the action of a point source lying on the axis of the parabola but ahead of or behind the focal point.

2.1.2—*Ellipsoidal Reflectors* — **(a)** Ellipsoidal reflectors are used in light control to produce beams of controlled divergence. The ellipse (Fig. II-5) drawn on rectangular coordinates can be described by the equation:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, \text{ or } b^2x^2 + a^2y^2 = a^2b^2$$

The vertices would be at $-a,0$ and $a,0$. The major axis, a line joining the two vertices would be equal to $2a$; the minor axis equal to $2b$. Every ellipse, as shown in Fig. II-5, has two foci, symmetrically located with respect to the minor axis, and two corresponding directrices. The sum of the two focal radii drawn to any point on the curve is a constant and is equal to the length of the major axis.

(b) Another way of defining an ellipse is as the locus of a point the sum of whose distances from two fixed points is a constant. This provides one method of drawing an ellipse. (A loop of string with the right amount of slack is placed around two pins at the foci. A marker is placed in the string and moved around the two pins, keeping the string taut. Since the amount of slack is constant, the marker will trace out an ellipse.)

(c) If a tangent T-T' is drawn to an ellipse (Fig. II-6), the tangent will bisect the external angle formed by the two focal radii drawn to the point of contact (M), and a perpendicular erected to the tangent at M will bisect the internal angle. It follows that the two foci are focal points optically as well as mathematically. If an ellipsoidal mirror is formed of the shape generated by rotating an ellipse about its major axis, a ray of light passing in any direction through one focal point will be reflected through the second focal point (angle TMF_1 = angle $T'MF_2$, as shown in Fig. II-6) and will be returned through the first focal point, ad infinitum.

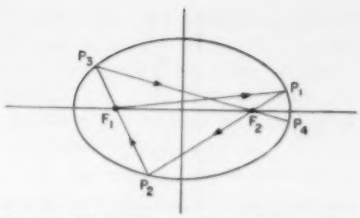


Figure II-7. The action of a perfect ellipsoidal mirror.

(d) Fig. II-7 illustrates the action of a perfect, complete ellipsoidal mirror with a light source at F_1 and a ray of light striking the mirror at P_1, passing through F_2 to P_2, and being reflected again through F_1 to P_3 and on to P_4. It would appear from this that if a small hole were made in the mirror on the major axis, all of the light produced at the source would eventually pass through. However, this is not true, since the source must have a finite size, forming an obstruction and placing part of the source off the focal point, and the reflectance of the mirror cannot reach 100 per cent. If the hole is made larger until the mirror is, in effect, "chopped off" at the focal point as in Fig. II-8 or at any point closer to the source, all of the light from the theoretical source at the other focal

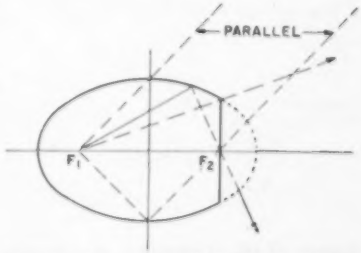


Figure II-8. An ellipsoidal mirror "chopped off" at one focal point.

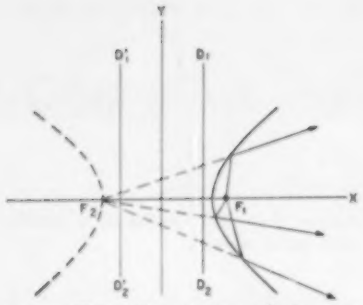


Figure II-9. Hyperbolic reflector action. Source at F_1, virtual image at F_2.

point will leave the mirror either directly or after one reflection. By moving the opening back along the major axis, the beam limits of the reflected light are narrowed. When the plane of the opening reaches the center point of the ellipse, the maximum angle of the reflected light coincides with the angle of the direct light from the source.

2.1.3—*Hyperbolic Reflectors*—The diverging beam typical of the ellipsoidal reflector can also be produced by a reflector having a hyperbolic contour. The main difference, as shown in Fig. II-9, is that the hyperbolic reflector will form a virtual image behind the focus, whereas the ellipsoidal reflector produces a real image in front of the focus.

2.1.4—*Spherical Reflectors*—A spherical reflector can be considered as a special form of the ellipsoidal reflector where the two foci are coincident. Any light leaving the source located at the focus would return and pass through the same point. This has obvious disadvantages when dealing with practical sources since the concentration of energy can often have a damaging effect on the source or the bulb wall surrounding it. The principle is, however, often used in projecting devices to increase the amount of light collected by a lens as shown in Fig. II-10.

2.2—*General Reflector Contours*

—(a) A general reflector problem is that of determining the shape of a reflector which is not mathematically predictable as to contour and action. Usually two known factors are: (1) an approximate candlepower distribution curve for the finished reflector, and (2) the material from which it is to be manufactured.

(b) The nature of the reflecting surface will influence reflector action. The surface will fall into one of three classifications:

(1) Surfaces with perfectly diffuse reflection.

(2) Surfaces with purely specular reflection.

(3) Surfaces exhibiting a mixture of diffuse and specular reflection.

2.2.1—*Diffuse Reflecting Surfaces*—In the rare case of surfaces with perfectly diffuse reflection, the contour of the reflector will have very little effect on the distribution of light. The candlepower distribution curve of such a reflector (after that portion due to the bare lamp had been deducted) would be very nearly a circle, with the maximum ordinate normal to the plane of the opening. The distribution curve would be even closer to a circle except that all portions of the reflector would not be uniformly illuminated. A unit strip of area near the lower edge of the reflector, being farther from the source, would receive less light than a similar strip higher in the reflector. Since these lower portions are the parts directing light out at the upper angles, the candlepower is less near the horizontal than straight below. In this case there is little that can be done by the designer in the way of light control except by aiming the entire reflector.

2.2.2—*Reflectors with Specular and Semi-Specular Surfaces*—**(a)** General contours for specular reflectors are usually obtained through graphical rather than strictly mathematical methods. The problem consists of determining what reflector shape is necessary to redirect luminous flux from the lamp into the proper directions to achieve a predetermined candlepower distribution curve.

(b) The basic steps in one method of determining reflector contour are as follows (a simple example using this procedure is shown in Appendix A):

(1) Select the width, in degrees, of zones to be considered. From the required candlepower distribution curve (polar curve), calculate the luminous flux required in each zone (candlepower times zonal constant for each zone). See Appendix B. Tabulate.

(2) Calculate the luminous flux emitted by the bare lamp in each zone (using the polar curve of the bare lamp and zonal constants). Tabulate.

(3) Find the reflected lumens needed in each zone by subtracting the bare lamp lumens (data from Step 2) from the required luminous flux (data from Step 1) in those zones where no reflection will take place, *i.e.*, from nadir up to cut-off. Tabulate.

(4) Decide upon the general action of the reflector. There are, in general, four basic actions of reflectors as shown in Fig. II-11. For a given cut-off, the forms shown in Figs. II-11*c* and II-11*d* usually require a very large reflector. The form shown in Fig. II-11*b* has the disadvantage that much of the light is passed through the lamp bulb. For most cases, the form shown in Fig. II-11*a* results in the smallest reflector and redirects the least light back through the lamp.

(5) Plot a curve of reflected flux obtained in Step 3. Starting at 0 degrees, show cumulative sums of lumens required to be reflected into each zone from nadir up to cut-off (Fig. II-12*a*). Similarly, plot a curve of available lamp flux (from Step 2 data). Starting at cut-off, show how many lumens are incident on the reflector progressively from cut-off to 180 degrees (Fig. II-12*b*). Since all flux considered here must be reflected from the reflector

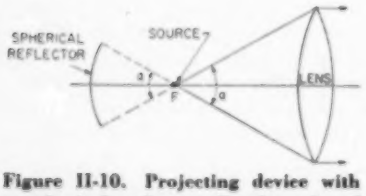


Figure II-10. Projecting device with a spherical reflector. Total angle of collection including reflector = 2a.

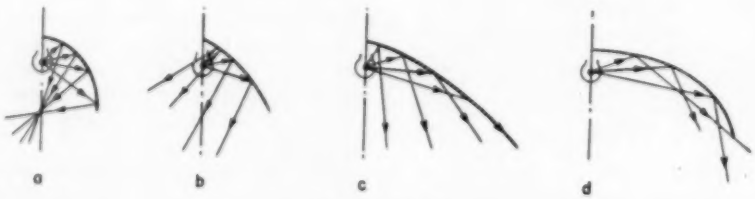


Figure II-11. Four basic reflector actions.

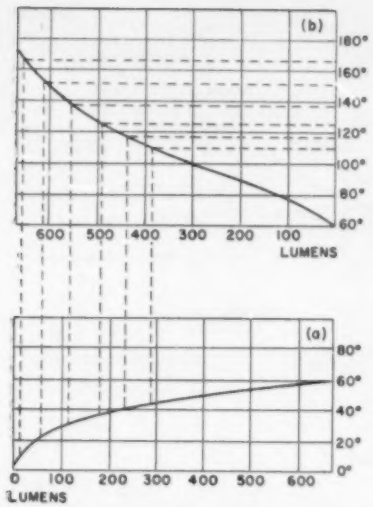


Figure II-12. Reflection plan of available lamp lumens (shown for 60 degrees cut-off). (a) Reflected flux curve. (b) Incident or available flux curve (corrected for losses).

surface, the available lamp lumens must first be multiplied by the reflectance of the surface and by other loss factors. It is convenient to work with rectangular coordinates, plotting lumens along the horizontal axis and degrees along the vertical axis. Plot the reflected flux curve (Fig. II-12*a*) to the same scale and directly below the available lamp flux (bare lamp flux corrected for losses) curve. If the reflector action illustrated in Fig. II-11*b*, *c* or *d* was selected the horizontal (lumen) scales of the two curves will be in the same direction. If Fig. II-11*a* was selected the scales will be reversed as shown in Fig. II-12. Take intercepts at intervals (one for each zone) along the reflected flux curve (Fig. II-12*a*) and project upward to the available lamp flux curve as shown in Fig. II-12. At the point where each intercept cuts the available lamp flux curve (Fig. II-12*b*), project horizontally to degrees on the vertical axis. The spacings between intercepts on the vertical axis indicate how large an angular, zonal segment of the reflector is required to direct enough light at a particular angle to satisfy the requirements of the reflected flux curve.

(6) Lay out the reflector contour by starting at the point nearest the lamp and progressively drawing small, straight segments (one segment for each zone). Each segment must be of the required length, and placed in the correct position for the flux striking it to be reflected in the amount and direction determined in Step 5. Obtain the final contour by drawing a smooth curve tangent to the segments.

(c) The procedure outlined above assumes a point source and true specular reflection. The effect of a normal filament would be to smooth out the final distribution, rounding off sharp points. The effect will be more noticeable as the reflector gets smaller in comparison with the source.

(d) Departures from true specularity will have a similar effect, which will increase as the proportion of diffuse to total reflection increases. With semi-specular surfaces the effect of specularity of the surface increases as the angle of incident light increases. Hence, for accurate control of the light, it is well to keep the angle of incidence as large as possible.

(e) The above treats only symmetrical reflectors. Non-symmetrical reflectors are of a special case and are usually designed by either graphical or empirical methods.

3. Fundamentals of Optical Refraction — Graphical Methods

Optical refraction problems can be solved mathematically or graphically. Light rays are directed through transparent media in accordance with Snell's Law, where $n_1 \sin i = n_2 \sin r$. Mathematical solutions are reached by repeated applications of Snell's Law.

3.1—*Refraction at a Plane Surface* — Fig. II-13 illustrates the graphic solution of a basic refraction problem where the incident ray, line *i*,

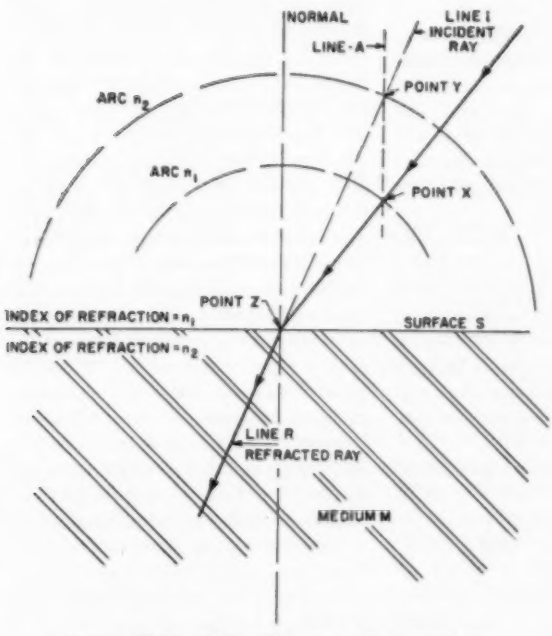


Figure II-13. Refraction at a plane surface.

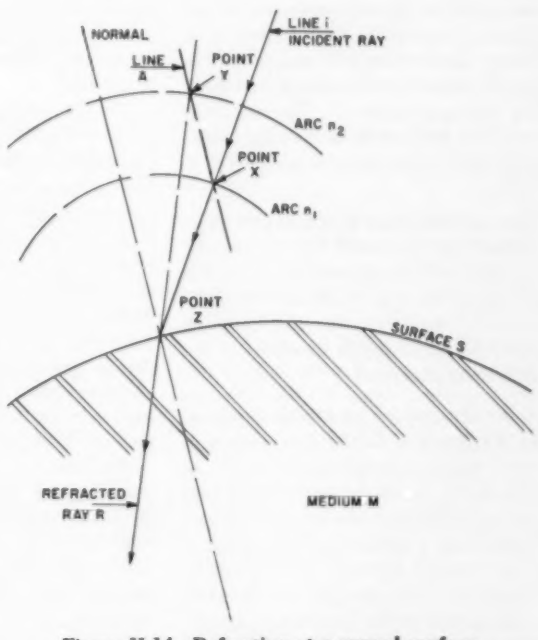
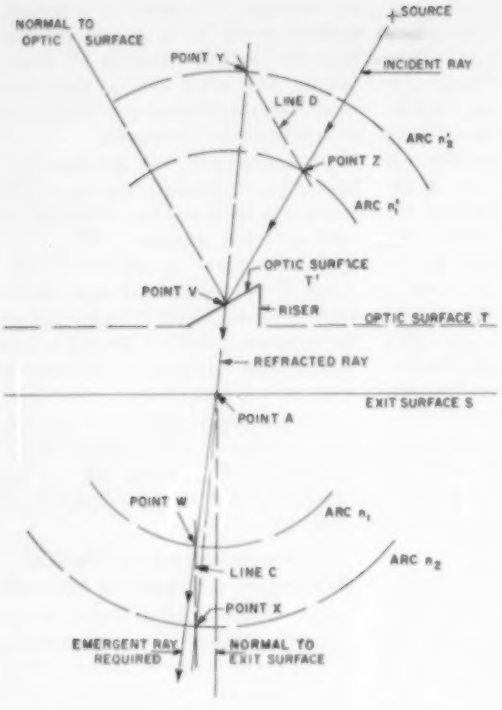


Figure II-14. Refraction at a curved surface.



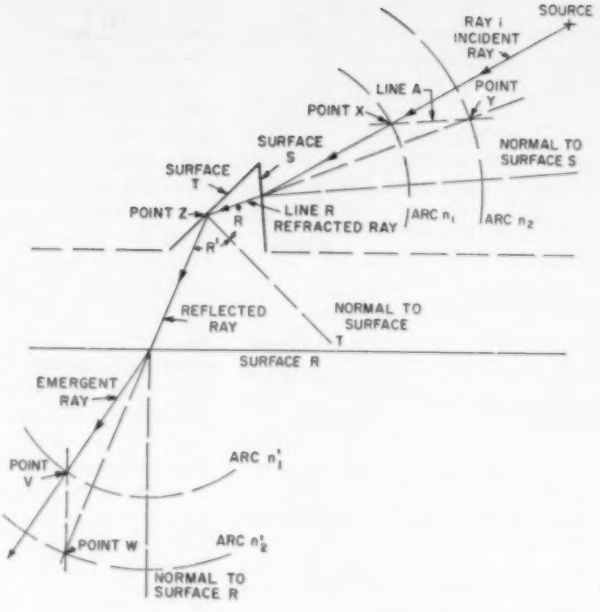


Figure II-15 (left). Design of an optic to redirect a light ray. Figure II-16 (above). Path of a light ray through a refraction-reflection system.

the normal to surface S at the point of incidence, and the indices of refraction of the two media are known. The direction of the refracted ray is required. With the point of incidence Z as center, two arcs are drawn, the radii in proportion to the two indices of refraction (radius arc n_1/radius arc n_2 = n_1/n_2). At point X, the intersection of arc n_1 and the incident ray, line A is drawn parallel to the normal, intersecting arc n_2 at point Y. The refracted ray R in medium M is then the extension of the line connecting points Y and Z.

3.2—*Refraction at a Curved Surface*—The graphical solution to refraction at a curved surface is identical to that in 3.1. Fig. II-14 illustrates the method where the normal connects point Z and the center of radius of the refracting surface S.

3.3—*Design of an Optic Surface to Redirect a Light Ray*—(a) A more common problem, illustrated in Fig. II-15, is the determination of an optic surface to cause the eventual refraction of a light ray from a source to a required direction. Initially, five elements of this problem are known:

(1) Exit surface S, which is the side of the lens away from the source. This surface could be flat, spherical, cylindrical, or irregularly shaped, the basic fundamentals being the same.

(2) Optic surface T to which an optical configuration must be designed in order to create the required distribution of light rays. Surface T is normally parallel to exit surface S.

(3) The location of the light source.

(4) The incident ray from the source to the lens.

(5) The required emergent ray. The angle of the optic surface T' which will change the incident ray to the direction of the emergent ray is the unknown quantity in this problem.

(b) The first step is to draw all the known components of the problem: exit surface S, optic surface T, incident ray, emergent ray required, and the source. Note that the surface T is a dashed line indicating that at the end of the complete design this surface will no longer be smooth, but will be configurated with optic elements.

(c) To point A, the intersection of the emergent ray and exit surface S, draw the normal to exit surface S. With point A as center strike arc n_1 with radius proportional to n_1, the refractive index of the outside medium (probably air where $n_1 = 1$). Again with point A as the center strike arc n_2 with radius proportional to the refractive index of the optical medium. Through point W, the intersection of arc n_1 and the emergent ray required, draw line C parallel to the normal to exit surface S. Through the intersection of arc n_2 and line C, which is indicated as point X, draw the construction line to point A on exit surface S. Extended, this becomes a refracted ray through the optic surface T. Further extended, it intersects arc n'_2 at point Y. The radius of arc n'_2 is proportional to the refractive index of the optical medium. Note that the center of this arc, point V, lies on the optic surface which has not yet been established. This fact indicates that a few trials are necessary for this solution. The initial steps are repeated until point V coincides with the intersection of the incident ray and optic surface T'. With point V as center strike arc n'_1, whose radius is proportional to the refractive index of the outside medium. Draw line D between point Y and point Z, the intersection of arc n'_1 and the incident ray. The normal to the optic surface T' is then drawn parallel to line D and intersecting point V. The optic surface T' is then a line perpendicular to this normal.

(d) All rays at an internal angle to

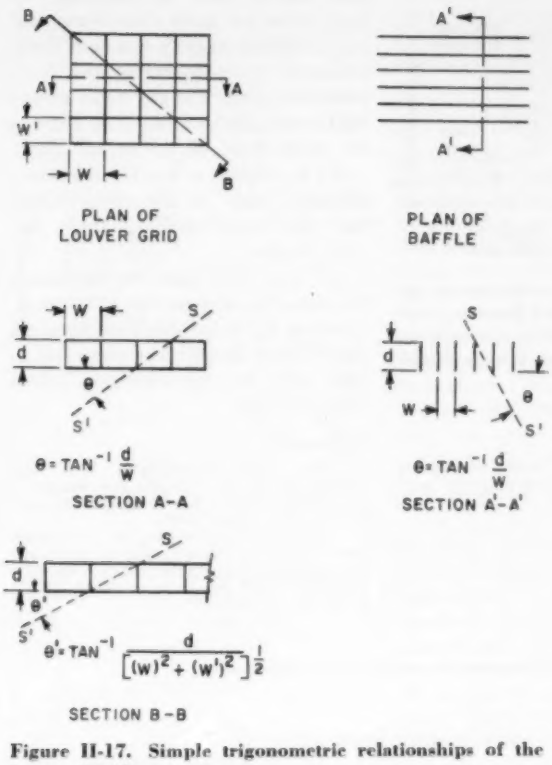


Figure II-17. Simple trigonometric relationships of the louver shielding angle.

PATTERN	ASSUMED θ IN A-A	MINIMUM θ IN B-B	ANGLE Ψ
SQUARE CELL	45°	35°	45°
SINE-WAVE CELL	45°	35°	45°
HEXAGONAL CELL	45°	41°	30°
CIRCULAR CELL	45°	45°	ANY ANGLE
BAFFLES	45°	0°	90°

Figure II-18. Shielding angle characteristics of different louver cell patterns.

the normal greater than critical angle ($\sin\theta = n_1/n_2$) are internally reflected from the inside of the surface.

3.4 — *Refraction-Reflection System*—(a) Total internal reflection is used extensively in lens design when rays must be bent at an angle larger than is possible to accomplish with refraction alone. Total internal reflection problems can be solved graphically by methods similar to those used in solving refraction problems.

(b) Fig. II-16 illustrates the solution of a typical problem involving both refraction and total internal reflection. A ray of light from the source passes through the system in the following manner:

(1) Ray i is refracted at surface S.
(2) Refracted ray becomes incident to surface T at an angle greater than the critical angle of the medium.
(3) Total internal reflection occurs at surface T so that $R' = R$.
(4) Reflected ray becomes incident on surface R.
(5) Ray is refracted at surface R and emerges from system.

(c) The graphical method of determining the refracted rays has been described in the previous section. The graphical method of determining the reflected ray is accomplished by constructing the angle of reflected ray to normal equal to the angle of the incident ray to normal.

4. Lamp Concealment by Shielding

4.1—*Definitions*

4.1.1—*Baffle*—A single shielding element.

4.1.2—*Louver or Louver Grid* — A series of baffles arranged in a geometric pattern.

4.1.3—*Cell Size* — Dimensions of the individual cells formed by a louver.

4.2—*Shielding Angle*—The fundamental mathematics of lamp concealment with baffles, louvers and reflectors is the simple problem of determining shielding angle. Two shielding angles of primary concern are the louver shielding angle and the lamp shielding angle.

4.2.1—*Louver Shielding Angle*—**(a)** The louver shielding angle (θ) is defined as the angle between the horizontal plane of the baffles or louver grid and the plane at which the louver conceals all objects above. As shown in Fig. II-17, this is generally the angle (θ) between the horizontal and a plane (S-S') which intersects the lower edge of one row of louver blades and the upper edge of the next.

(b) The louver shielding angle is usually evaluated only in directions perpendicular to the louver blades. It may also be evaluated along the cell diagonals. In either case the angle (θ) is determined by simple trigonometric relationships (Fig. II-17).

(c) There are many louver patterns and combinations. The circular cell pattern provides a uniform horizontal shielding angle in all directions. For other patterns, if the louver blades are of uniform depth the shielding angle is smaller along the cell diagonals than at perpendiculars to the blades. This is illustrated for square, sine-wave, hexagonal and circular patterns in Fig. II-18. These four patterns are easily analyzed, and indicate the characteristics of most others.

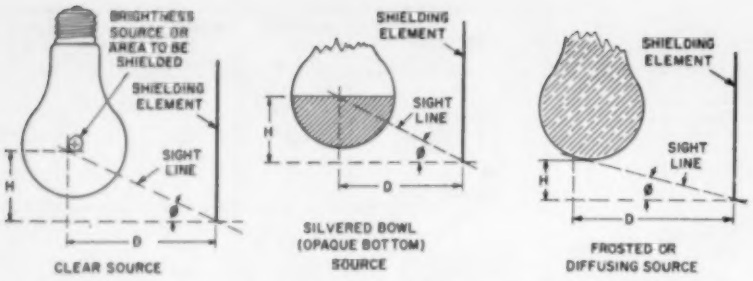


Figure II-19. The lamp shielding angle is formed by a sight line tangent to the lowest part of the brightness area to be shielded. *H* is the vertical distance from the brightness source to the bottom of the shielding element. *D* is the horizontal distance from the brightness source to the shielding element. Lamps shielding angle $\phi = \tan^{-1} H/D$.

4.2.2 — *Lamp-Shielding Angle* — **(a)** The lamp-shielding angle (ϕ) is the angle between (1) the horizontal, or the horizontal plane of the baffles or louver grid, and (2) the line most nearly horizontal from the source to be shielded and the bottom of the louver blades (or shielding element) as shown in Fig. II-19.

(b) Lamp-shielding angle must not be confused with the angle of cut-off. The cut-off angle is measured from nadir up to where the shielding element hides the lamp from view; the lamp shielding angle is measured from horizontal down to where the lamp comes into view. For any given shielding element, the lamp-shielding angle is the complement of the cut-off angle.

(c) In relation to louvers, the lamp-shielding angle is frequently larger than the louver shielding angle, but never smaller.

(d) Fig. II-19 illustrates the simple trigonometric relationships of the lamp-shielding angle (ϕ) for three types of incandescent lamps. The same principles apply to any brightness source being shielded.

References

1. Jolley, L. B. W., Waldram, J. M., and Wilson, G. H.: *The Theory and Design of Illuminating Engineering Equipment*, Chapman & Hill, Ltd., London, 1930.
2. Potter, W. M. and Oetting, R. L.: "Design and Illumination Characteristics of Louver and Louverall Systems," ILLUMINATING ENGINEERING, Vol. XLIV, No. 1, p. 16; No. 6, p. 341 (January and June 1949).

APPENDIX A—EXAMPLE OF DESIGN OF REFLECTOR CONTOUR.

Assume that a specular reflector is required to produce the candlepower distribution curve shown in Fig. A-1. A cut-off angle of 60 degrees is required. The shape of the curve rather than the magnitude is the prime consideration.

STEP 1—Table A-1 shows the amount of luminous flux in each 10-degree zone from 0 (nadir) to 180 degrees. This is obtained by multiplying the mid-zone candlepower in each zone by the appropriate zonal constant (Appendix B). A more rigorous treatment would use smaller zones and would use the average candlepower throughout each zone rather than the mid-zone candlepower.

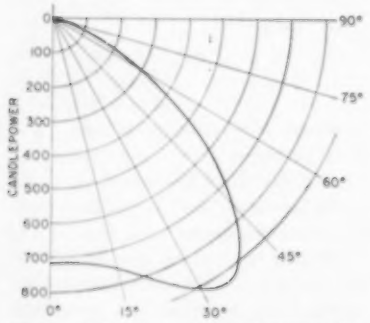


Figure A-1. Desired candlepower distribution curve of finished reflector.

STEP 2—Assuming that the reflector will have a final efficiency of 70 per cent, the bare lamp lumens must be 2410/.70 or 3440 lumens. The nearest incandescent lamp to this would be the 200-watt lamp having 3700 lumens. Assume the polar curve for the bare lamp to be that shown in Fig. A-2. Using the zonal constant method the lumens in each zone can be calculated as shown in Table A-II.

STEP 3—All bare lamp flux from 0 to 60 degrees from nadir will leave the luminaire unchanged in direction. The bare lamp flux from 0 to 60 degrees totals 946 lumens. The balance (3700 − 946 = 2754) must be reflected from the reflector and will be reduced according to the reflectance of the surface, taken here as 80 per cent. An additional loss of about 15 per cent may be assumed to account for losses when light is redirected through the lamp bulb after reflection. Hence the total lumens in the final curve would be $946 + 2754 \times .80 \times .85 = 946 + 1870 = 2816$. Since this is more than the 2410 lumens required, the lumens required in the final curve must be multiplied by the ratio 2816/2410 to keep the same curve shape even though the magnitude will be increased. The new lumen values are shown in the second column of Table A-III. The third column shows the bare lamp contribution in the 0- to 60-degree zone. The fourth column shows

Table A-I—Proposed Luminaire Data.

Zone	Mid-zone Candlepower	Zonal Factor	Zonal Lumens
0-10	720	0.095	68
10-20	755	0.283	213
20-30	855	0.463	396
30-40	930	0.628	584
40-50	745	0.774	576
50-60	450	0.897	403
60-70	150	0.993	149
70-80	20	1.058	21
80-90	0	1.091	....
		TOTAL =	2410

Table A-II—Bare Lamp Data.

Zone	Mid-zone Candlepower	Zonal Factor	Zonal Lumens
0-10	292	0.095	28
10-20	291	0.283	82
20-30	289	0.463	134
30-40	294	0.628	185
40-50	305	0.774	236
50-60	313	0.897	281
60-70	313	0.993	311
70-80	306	1.058	324
80-90	290	1.091	316
90-100	275	1.091	300
100-110	281	1.058	297
110-120	296	0.993	294
120-130	304	0.897	273
130-140	306	0.774	237
140-150	297	0.628	186
150-160	292	0.463	135
160-170	251	0.283	71
170-180	101	0.095	10
		TOTAL =	3700

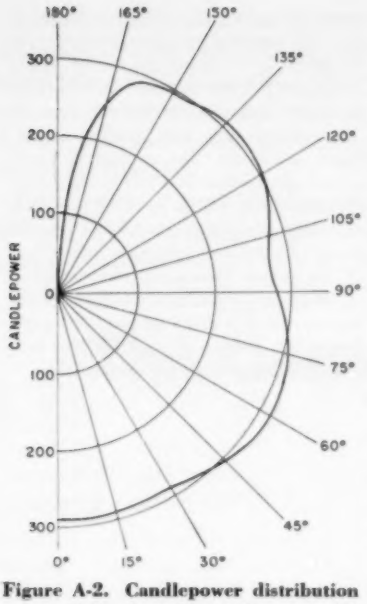


Figure A-2. Candlepower distribution curve of the bare lamp (for use with the hypothetical example only.

the balance which must be supplied by the reflector.

STEPS 4 AND 5—For the reasons discussed previously in 2.2.2(b)(4) the general reflector action shown in Fig. II-11*a*, page 780 will be used. The next step then is to express the final curve (minus bare lamp contribution below cut-off) and the bare lamp curve in terms of total lumens emitted up to each angle from nadir. These data are tabulated in Table A-IV and drawn in Fig. A-3. Note that the bare lamp curve begins at the cut-off angle and all values are reduced in accordance with reflection and absorption losses listed above. From the lower curve on Fig. A-3 (representing lumens leaving the reflector) intercepts at convenient intervals are taken and projected upward as indicated by the dotted lines. The intersection of the dotted lines and the upper curve (representing available lamp lumens) indicates how large an angular segment of the reflector is required to direct the necessary amount of flux into each zone.

STEP 6—The reflector contour is now determined by starting at the point nearest the lamp and drawing small segments to reflect the flux into the particular zones determined in Steps 4 and 5 above, and tabulated in Table A-V. One graphical method of laying out the contour (not necessarily the only method or the best) is illustrated in simplified form in Fig. A-4. The procedure is as follows: Assuming the light source at 0 in Fig. A-4 the angular segments about the source as determined in Steps 4 and 5 are drawn in at 160 degrees, 144 degrees, 123 degrees, 99 degrees, etc., from nadir. From Table A-V the incident flux in the 160- to 180-

Table A-III—Reflected Lumens Required.

Zone	Corrected Lumens Required	Direct Light Bare Lamps	Balance Required
0-10	79	28	51
10-20	249	82	167
20-30	463	134	329
30-40	683	185	498
40-50	673	236	437
50-60	470	281	189
60-70	174	....	174
70-80	25	....	25
80-90	....	....	....
TOTALS	2816	946	1870

Table A-IV—Flux Summation Values.

Angle	ΣA*	ΣB**
0		
10	51	
20	218	
30	547	
40	1045	
50	1482	
60	1671	
70	1845	211
80	1870	431
90		646
100		850
110		1052
120		1252
130		1437
140		1597
150		1723
160		1815
170		1863
180		1870

*ΣA = Progressive summation of lumens required for final curve minus bare lamp contribution in the 0-60-degree zone.
**ΣB = Progressive summation of lumens available from lamp after losses are deducted.

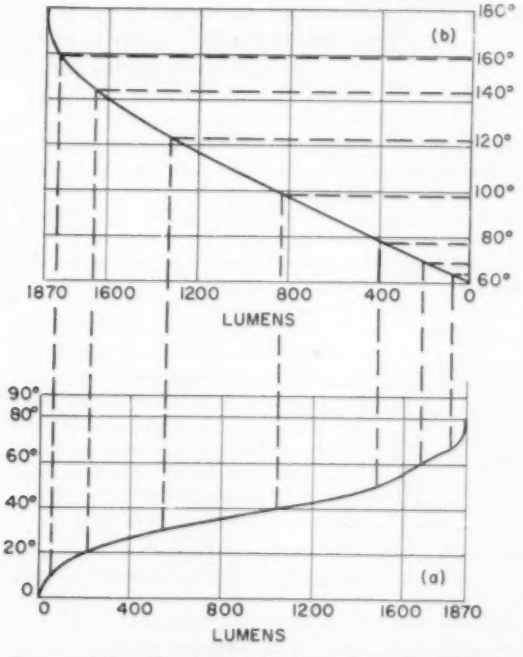


Figure A-3. Showing reflection plan of available lamp lumens. (a) Reflected lumens. (b) Available lamp lumens (corrected for losses).

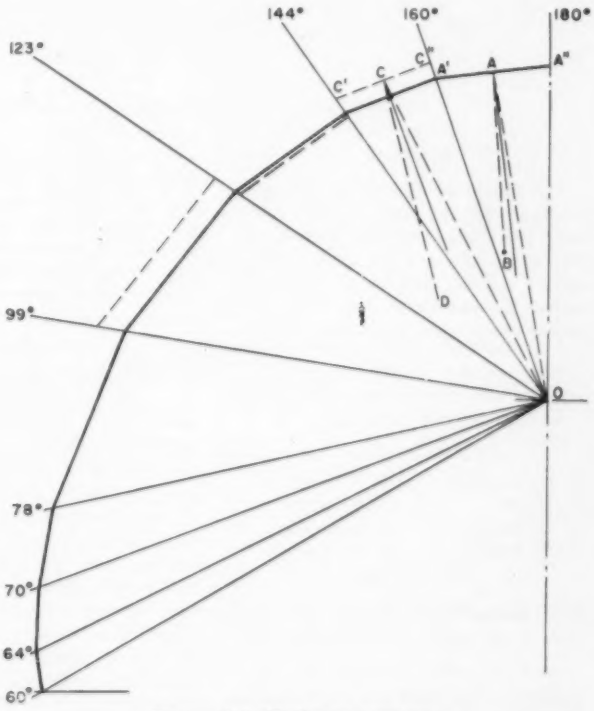


Figure A-4. Reflector contour.

Table A-V—Flux Reflection Chart.

Flux Emitted in Zone	Reflected into Zone
160°-180°	0°-10°
144°-160°	10°-20°
123°-144°	20°-30°
99°-123°	30°-40°
78°-99°	40°-50°
70°-78°	50°-60°
64°-70°	60°-68°
60°-64°	68°-90°

degree zone is to be reflected into the 0- to 10-degree zone. As an approximation one mid-zone ray can be used at 170 degrees (line OA) and reflected back to the center of the 0- to 10-degree zone at five degrees (line AB). The normal to the bisector of angle OAB represents the reflector slope for the first segment (line $A'A''$). The second angular segment, 144 degrees to 160 degrees, is treated in a similar fashion, resulting in line $C'C''$. Since point C is taken at random, it would be sheer happenstance if point C'' coincided with point A'. Hence, a line parallel to $C'C''$ is drawn starting at A', thus establishing the reflector slope for the second angular segment. The rest of the zones are treated in the same way, resulting in a continuous reflector from 180 degrees down to the cut-off angle, in this case 60 degrees from nadir. A smooth curve, tangent to each segment, is normally drawn at this point.

While rather large angular segments are used in the illustrative example above, in most practical cases it is preferable to use smaller segments for increased accuracy. It is also worth noting that the distribution curve chosen, with considerable flux above the cut-off angle, requires a reflector contour which returns back past nadir near the cut-off angle.

One factor has been ignored in the above treatment. The method is based on the assumption that the source is of negligible size, which is rarely the case in actual practice. This alters to some extent the final distribution, the extent of the change increasing as the size of the reflector decreases with respect to the source. Since a given portion of the reflector can occupy but one position at a time, this error cannot be eliminated.

APPENDIX B—CONSTANTS FOR USE IN THE ZONAL METHOD OF COMPUTING LUMINOUS FLUX FROM CANDLEPOWER DATA—see Fig. A-13, *IES Lighting Handbook*, Third Edition, p. A-13.

ADDENDA to IES Guide for Life Performance Testing of Fluorescent Lamps

Prepared by the Subcommittee on Revision of IES Guide for Life Performance Testing of Fluorescent Lamps of the Committee on Testing Procedures of the Illuminating Engineering Society

FOREWORD

The following material replaces those Sections with the same numbers in the 1956 IES Guide for Life Performance Testing of Fluorescent Lamps. These revised Sections have been prepared to include the new lamps and testing techniques which are now available.

SUBCOMMITTEE ON REVISION OF IES GUIDE FOR LIFE PERFORMANCE TESTING OF FLUORESCENT LAMPS

Priscilla Presbrey, *Chairman*

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E. M. Kooker — A. W. Weeks
S. W. Wilson

3.1—*Ballasts*—(a) Ballasts used in life tests should comply with American Standard Specification for Fluorescent Lamp Ballasts, C82.1; in addition, the current delivered to a reference lamp should be within plus five per cent or minus three per cent of that delivered to the same lamp by a reference ballast. All ballasts should be checked periodically to ensure that they remain within the recommended limits.

3.4—*Burning Position*—It is customary to burn the lamps in a horizontal position, similar to the usual position in a luminaire. Mounting lamps directly above each other may cause unequal heating of upper and lower lamps, especially if the lamps are too close together. The handling of highly-loaded lamps removed from the burning rack for photometric measurements requires special care to reduce the time necessary for restabilization. The necessary precautions vary with the type of lamp; in general, they involve keeping the lamp in a horizontal position when it is transported from the burning rack to the photometer.

3.5 — *Lamp Connections* — (a) With preheat-start lamps, the same two contact pins should be connected to the operating circuit during life testing as for photometric and electrical measurements. Recommended procedure is given in the IES Guide for Electrical Measurements of Fluorescent Lamps.

(b) In the testing of rapid-start lamps, it is important that cathode-heating circuit continuity be maintained at all times. Checks should be made whenever lamps are placed on the burning rack, and periodically thereafter. Testing can readily be done by means of a flashlight lamp encased in transparent plastic and connected to a fluorescent lamp base.

3.6 — *Adjacent Ground* — A grounded metal strip at least as wide as the lamp diameter should be installed behind each lamp under test. The spacing between the strip and the bulb wall should be such as to simulate usual conditions in luminaires. In no case, however, should the distance be greater than one inch.

Approved by the Council of the Illuminating Engineering Society, September, 1959. A Transaction of the Society.

In accordance with the By-laws of the Society, the General Secretary submits the following report for publication in ILLUMINATING ENGINEERING. Based on material recorded by Officers, Committees and Sections and Chapters, this report has been prepared with the assistance of the Managing Director, A. D. Hinckley.

Parts of the report were presented at the Society's Annual Meeting at the opening session of the National Technical Conference, September 7, 1959, in San Francisco.

The General Secretary Reports

By JAMES R. CHAMBERS

Membership

Statistics—Membership of the Society continued to grow during the past fiscal year. The usual losses due to resignations, dropped dues delinquents and the loss of deceased members, were more than made up by the gains. The totals in Table I reflect the gains and losses shown in Table II. The overall membership growth is shown in Fig. 1. Table III records the membership by grade in the respective Sections and Chapters, as well as the non-Section membership.

Members Emeritus, Fellows—Upon recommendation of the respective Boards, Council approved elections this year of three in Emeritus status and eight in Fellow grade. Emeritus:

Raymond C. Kinney—Member
Thomas W. Aolph—Fellow
C. E. Weitz—Fellow

Fellows:

R. D. Bradley	L. E. Johnson
G. W. Clark	E. A. Linsday
B. C. Cooper	S. M. McCandless
R. T. Dorsey	Priscilla Presbrey

Deceased—The Society records with sorrow the death of two Fellows Emeritus, one Member Retired, 19 Members and 24 Associate Members during the fiscal year.

Fellows Emeritus

Simpson, Richard C.
Stickney, George H.

Member Retired

Miller, Robert A.

Members

Barry, James R.	Martin, B. J.
Briggs, Milo A.	McCarron, John F., Jr.
Earley, Harold P.	Mertens, C. E.
Ellis, George J.	Morton, Walter B.
Fawcett, C. D.	Nadeau, Adelard T.
Hansman, George D.	Omin, William W.
Keister, Theodore F.	Strahn, Harold I.
Lattin, Robert R.	Strecker, Charles E.
Lothrop, R. K.	Vavrinek, LeRoy J.
Westrick, Marvin V.	

Associate Members

Barlogi, Garland R.	Getman, M. W.
Campbell, Guy	Heenan, Leo J.
Carter, Hilton P. M.	Larouche, Pierre-Michel
Clark, Henry James	Mozes, David
Cohn, Stanley P.	Orth, Carl F., Jr.
Connell, T. J.	Pereira, Dulcidio
Denmark, Alexander S.	Shreve, Warren P.
Donahue, Frank S.	Voos, Ernest G.
Donahue, H. Brian	West, Fred R.
Dupree, Joe T.	Willis, Otto
Ehorn, Robert E.	Wilson, Edward J.
Ferguson, R. E.	Zito, Albert F.

Regional Activities

The Regional Activities Committee, made up of the eleven Regional Vice-President with R. G. Slauer, Vice-President, as Chairman, again carried on an active program of assistance to the Sections and Chapters and to the regional operation. A majority of the Regions scheduled meetings of key Section/Chapter officers and chairmen in the fall for organizational planning. All Regions (with the exception of South Pacific Coast) scheduled a similar meeting in connection with their Regional Conference.

The Regional Activities Committee held four full-day meetings, in conjunction with Council meetings. Included in the agenda of these meetings was the discussion of reports on a number of study projects undertaken by the Regional Vice-Presidents. The

TABLE I—Membership as of September 30.

	1954	1955	1956	1957	1958	1959
Members and Fellows Emeritus	34	35	37	40	41	42
Fellows	78	89	99	106	113	119
Members	1,939	1,979	2,123	2,212	2,410	2,546
Associate Members	5,621	5,887	6,036	6,211	6,304	6,651
Student Members	230	188	185	157	116	128
Total	7,902	8,178	8,480	8,726	8,983	9,486

TABLE II—Gains and Losses in Membership During Year Ending September 30, 1959.

	Members/ Fellows Emeritus	Fellows	Members	Associate Members	Student Members	Total
October 1, 1958	41	113	2,409	6,304	116	8,983
Gains						
Elections			127	1,172	72	1,371
Reinstatements			31	103		134
Transfers	3	8	137	6		154
Total Gains	3	8	295	1,281	72	1,659
Losses						
Resignations			84	350	56	490
Dropped			43	423		466
Deceased	2		20	24		46
Transfers		2	11	137	4	154
Total Losses	2	2	158	934	60	1,156
Net Change	1	6	136	347	9	503
Total Membership as of September 30, 1959	43	119	2,546	6,651	128	9,486

A Transaction of the Illuminating Engineering Society.

TABLE III—Membership of Sections and Chapters as of September 30, 1959.

	Associate Members	Members	Students	Fellows	Members Emeritus	Fellows Emeritus	Total
CANADIAN REGION							
Bluenose Chapter	26	15					41
Forest City (London) Chapter	21	7					28
Golden West Chapter	29	7					36
Hamilton, Ont., Chapter	19	8					27
Maritime Chapter	41	10					51
Montreal Section	98	40					138
Ottawa Section	37	13					50
Quebec Chapter	48	5					53
St. Maurice Valley Chapter	19	5					24
Toronto Section	169	61		6	1		237
Winnipeg Chapter	38	7					45
EAST CENTRAL REGION							
Capital Section	70	47		7			124
Eastern Pennsylvania Section	107	42			1		150
Maryland Section	58	22		1	1		82
Philadelphia Section	214	87		4		1	306
Pittsburgh Section	135	70	2	2			209
Virginia Section	36	29			1		66
GREAT LAKES REGION							
Buckeye Chapter	37	10	1	2			50
Central New York Section	87	36	1	2			126
Cleveland Section	189	115		27	4	4	339
Miami Valley Section	49	10	2				61
Michigan Section	190	76	3	3	3	1	276
Northwestern Ohio Section	53	19	1				73
Ohio Valley Section	68	27			1		96
Rochester Section	110	22		1			133
Western Michigan Section	50	21					71
Western New York Section	86	14	2				102
INTERMOUNTAIN REGION							
Arizona Section	77	26					103
New Mexico Chapter	35	5	11				51
Rocky Mountain Section	55	24		1			80
Southern Colorado Chapter	15	9		1			25
Utah Section	44	21					65
MIDWESTERN REGION							
Central Kansas Chapter	28	5	2				35
Central Illinois Chapter	38	14					52
Chicago Section	320	127	2	6	3	3	461
Cornhusker Section	68	16	1				85
Heart of America Section	75	33	10				118
Indiana Section	63	28	2		1		94
Iowa Section	71	22					93
Milwaukee Section	185	36	2	2			225
Ozark Chapter	25	22					47
St. Louis Section	140	34		3			177
Twin City Section	159	31		1			191
Twin Ports Chapter	26	4					30
NORTHEASTERN REGION							
Connecticut Section	111	51		2	1	1	166
Eastern New York Section	54	17		1	1		73
New England Section	247	91	2	7	2		349
New Jersey Section	128	72	1	10			211
New York Section	284	149	6	11	1	1	452
Yankee Section	42	18					60
PACIFIC NORTHWEST REGION							
British Columbia Section	76	25					101
Chinook Chapter	36	11					47
Edmonton Section	59	15					74
Inland Empire Chapter	40	16					56
Oregon Section	66	31	10		1		108
Puget Sound Section	70	32	2	1			105
Vancouver Island Chapter	19	3					22
SOUTH CENTRAL REGION							
Alabama Section	74	25	1				100
Arkansas Chapter	20	5					25
Mid-South Chapter	25	10	16				51
Mississippi Chapter	28	6					34
New Orleans Section	83	24					107
Tennessee Valley Section	35	24	1				60
SOUTHEASTERN REGION							
Central Florida Chapter	25	9					34
Coastal Empire Chapter	17	7					24
Florida Section	62	25		1		1	89
Georgia Section	95	72	1				168
Palmetto Section	63	26		1			90
Southeast Florida Section	58	22	29	1			110
Suwannee River Chapter	22	13					35
Tar Heel Section	82	41		1			124
SOUTH PACIFIC COAST REGION							
Arrowhead Chapter	35	7					42
Golden Gate Section	230	56	3	2	1		292
Mother Lode Chapter	33	18		1			52
San Diego Section	76	25			2		103
San Jose Chapter	39	12	2	1			54
Southern California Section	227	88	4	4	1	2	326
Yosemite Chapter	39	14	1				54
SOUTHWESTERN REGION							
Alamo Section	38	8		2			48
Ark-La-Tex Chapter	32	14					46
Central Oklahoma Chapter	24	17	2				43
Coastal Bend Chapter	13	11					24
North Texas Section	125	34	1	2			162
Oil Capital Section	38	19					57
Panhandle Chapter	20	5					25
San Jacinto Section	44	26	1				71
South Plains Chapter	31	7					38
Mexico Chapter	28	4	1				33
Foreign Non-Section	150	59	2	2	2		215
TOTAL	6651	2546	128	119	29	14	9487

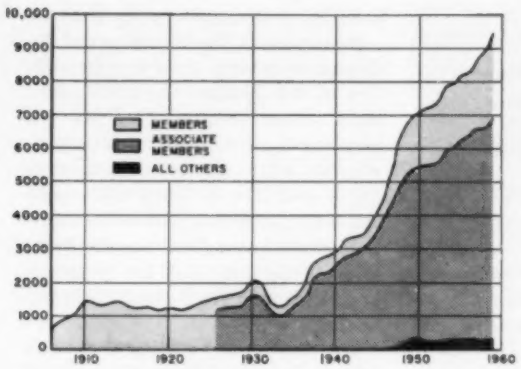


Figure 1. Membership: Total Members, Associate Members, all others.

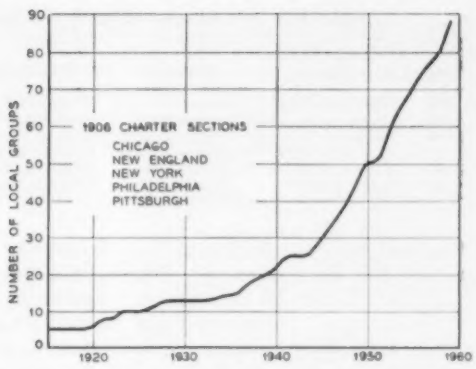


Figure 2. Growth of the Society in numbers of Sections and Chapters.

Regional Vice-Presidents also included in their discussions the subject of lighting equipment exhibits in conjunction with Section/Chapter meetings. Conclusion on this subject was that exhibits had considerable value but must be carefully regulated to avoid excess commercialism. Also considered was the question of Section/Chapter budget allotments leading to the conclusion that the present procedure and formula is adequate.

MMILJ — This important activity was discussed at length at several meetings leading to the general conclusion that the contest is worth while. Following the committee's recommendation, Council confirmed the appointment of a Task Committee to study the contest in preparation for the 1959-1960 operation.

Committee Study Projects — Active consideration was given by the Regional Vice-Presidents to a number of study projects prepared by the respective Regional Vice-Presidents. These, and related details and actions, were as follows:

Project No. 1—Past Chairman's Pin— It was agreed that the standard emblem of the Society be used, through the addition of a panel showing the words "Past Chairman," with the cost about $3.50 each, after an initial die cost of $160. Committee recommendation was approved by Council establishing Past Chairman's Pin, with the following conditions:

a. Badge color to denote membership grade at time of presentation of pin.

b. Sections and Chapters to decide locally how many badges they will secure to honor Past Chairmen. Sections and Chapters may purchase such badges from regular funds, if budget permits.

c. Badge to be made available at cost, with die cost underwritten by the Society.

Project No. 2—Guide for Section/Chapter Operation—It was decided to wait to determine the value of the proposed Section/Chapter Guide which had been mailed toward the end of the fiscal year to the new 1959-60 Section and Chapter Chairmen. It was agreed to refer the new Guide to the Regional Activities Committee of the incoming administration for study and approval.

Project No. 3—Regional Vice-President's Guide—It was agreed to await a report by Robert M. Taylor, 1957-58 Chairman, since one was reported as virtually complete.

Project No. 4—How to Conduct Section and Chapter Meetings—The preparation of this report was continued through the year.

Project No. 5—How to Organize New Chapters — Based on a preliminary study by George L. Morris, 1957-58 Chairman, this project was continued for study during the year.

Project No. 6 — Regional Conference Guide—A preliminary report by C. M. Thompson, 1957-58 Chairman on the subject, was in the form of a complete record of the experience of the South Pacific Coast Region in preparing for a Regional Conference. The project was continued for further study during the year.

Project No. 7—Lighting Course Operation — Following re-assignment of this project, a preliminary report was drafted and in circulation for study and approval at the end of the fiscal year.

Project No. 8—Agenda for Local Activities Meeting — The completion of this project provided a comprehensive outline to guide in the several meetings which might be held in each Region annually.

Project No. 9—Scope of Regional Conferences after 1960 — The project included study of the involvement of Sections and Chapters in each Conference, the part of the Regional Vice-President and the President, and the need for session papers to meet regional goals. A Task Committee continued the study during the year with the resulting decision that the present pattern of annual conferences in each Region be continued without change.

Project No. 10 — Material for Use at Study Club Meetings — This project was assigned for study during the year.

Section and Chapter Programs—The 88 Sections and Chapter of the Society all carried out programs of service through organization of their local memberships and committees. According to reports received at Headquarters, over 800 regular and special meetings were held during the year, mostly on a monthly basis.

A number of the local groups operated as a regular part of their local program, a study club or technical forum, offering the more detailed discussion of the technical aspects of illuminating engineering.

Residence Lighting Forums continue to be an important activity of ten of the Society's Sections.

Operating under the revised Guide prepared by the Lighting Service Committee, a majority of the Sections and Chapters scheduled "My Most Interesting Lighting Job" contests. Winners

TABLE IV—New Chapters Established During 1958-59.

No.	Chartered by Council	Name	Headquarters City	Region
83	October 9, 1958	Yosemite	Fresno, Calif.	South Pacific Coast
84	November 13, 1958	Arrowhead	San Bernardino, Calif.	South Pacific Coast
85	February 12, 1959	Central Florida	Orlando, Fla.	Southeastern
86	April 22, 1959	Central Kansas	Wichita, Kans.	Midwestern
87	May 21, 1959	Golden West	Regina, Sask.	Canadian
88	June 18, 1959	Buckeye	Columbus, Ohio	Great Lakes

in the local contests, which provided unusually fine local programs, went into Regional Conference competitions.

New Chapters and Sections—Six new Chapters were added to the rolls during the year, as listed in Table IV. Toward the close of the year, a group of members in the area of Oakland, California, were preparing to petition for a Section Charter, separating from the Golden Gate Section.

Local Representatives—The Sections and Chapters again handled the appointment of local representatives to carry on the work of the Society in areas not served directly by the local programs of Sections and Chapters. These members, in some instances, were organized into active Extension Committees.

Regional Conferences — Conferences were held in all of the Regions except South Pacific Coast, which was host to the 1959 National Technical Conference. Following the practice of recent years, the Southeastern and South Central Regions collaborated in the Conference at Asheville. The record of the 1959 Conferences follows, including the Chairmen of the Conference Executive Committees:

East Central—April 9-10—Lord Baltimore Hotel, Baltimore, Maryland. Chairman, H. M. White.
South Central-Southeastern — April 23-24 — Grove Park Inn, Asheville, North Carolina. Chairman, Walter E. Schwanhausser.
Southwestern — May 4-5 — Shamrock-Hilton Hotel, Houston, Texas. Chairman, G. L. McGonigle.
Midwestern—May 6-8—Pere Marquette Hotel, Peoria, Illinois. Chairman, Richard Weiman.
Inter-Mountain—May 11-12—Continental Hotel, Denver, Colorado. Chairman, James H. McCulloch.
Pacific Northwest—May 26-30—Banff Springs Hotel, Banff, Alberta. Chairmen, Don Frost and R. C. B. Jarvis.
Northeastern—June 4-5—Curtis Hotel, Lenox, Massachusetts. Chairman, Cliff Forster.
Canadian—June 11-12—Chateau Laurier, Ottawa, Ontario. Chairman, W. J. Montabone.
Great Lakes—June 22-23—Lafayette Hotel, Buffalo, New York. Chairman, Byron Lyth.

Finance

This committee, with W. P. Lowell, Jr., Chairman, continued its supervision of the financial affairs of the Society under the general direction of the Council.

The committee's work included the preparation of an operating budget and its presentation for Council adoption at the August meeting. This involved a review of the requests from all Sections and Chapters for budget allotments for the year.

In accordance with the action of Council, the Society's reserve account was in the hands of the Advisory Custodian Service of Irving Trust Company during the fiscal year. This provided professional management on a current basis. The Treasurer and the General Secretary, upon recommendation of the Finance Committee, continue to have the responsibility for investing Society funds in accordance with the policy approved by Council.

The committee reviewed and recommended for Council approval the financial reports for the 1958 National Technical Conference and the proposed budget for the 1959 National Technical Conference.

The printing and mailing of the new *IES Lighting Handbook* was reviewed carefully during the year in relation to the effect of direct expense and sales income on the operating funds. Happily, the sales income just about offset the expense items so that the over-all

Statement of Income and Expense for the Year Ending September 30, 1959.

INCOME

GENERAL ACTIVITIES			
Dues Individuals:			
Fellows		$ 2,016.00	
Member		43,976.83	
Associates		93,704.86	
Students		595.62	
Entrance fees		3,447.50	$143,740.81
Dues Sustaining Members:			65,505.14
Sales of publications (gross)			40,311.35
Sales of badges and certificates			923.00
IE Advertising			116,289.85
National Technical Conference:			
Gross receipts		15,511.00	
Expense		14,730.24	780.76
Income from Reserve Fund			5,176.34
Sundry income			202.35
TOTAL			$372,929.60

EXPENSES

General			$ 5,979.05
Office:			
Business and Managing Director		$ 77,621.58	
Technical		51,720.59	
Publications		60,573.74	189,915.91
Organization			50,364.35
Social Security			2,302.81
Pension			8,157.36
IE Advertising promotion			4,642.78
Publications stock and service			22,826.55
IE to members			69,848.14
Contributions to "Illuminating Engineering Research Institute"			20,500.00
Cost of badges and certificates			767.72
TOTAL			$375,304.67
Excess of Expenses over Income			2,375.07
Less: Transfer of portion of technical and publication offices expenses to handbook costs			8,076.20
Excess of Income over Expenses—General Activities			5,701.13
Special Activity			
IES Lighting Handbook, 3rd edition			
Sales Income	$73,423.05		
Advertising Income	32,591.92	106,014.97	
Less cost of sales, promotion, and selling expense to date		98,274.40	7,740.57
BALANCE OF INCOME TRANSFERRED TO GENERAL FUND SURPLUS			$ 13,441.70

financial situation was not affected.

The Annual Report on the Society's financial condition was presented to Council at the February meeting.

Fiscal Year Statements—The official financial statements for the year are as given in the report of the auditor, MacNichol, Johnson & Company. These include statements of income and expense for the fiscal year, and the balance sheet as of September 30, 1959. The current audit and statements depart somewhat from those given in previous years as a result of study and recommendations of the Committee and of the Managing Director. The changes bring the official reports closer to the forms followed in monthly reports to Council, and are intended to simplify and clarify the accounting records.

Constitution and Procedures

With R. F. Hartenstein, Chairman, the committee brought to completion the over-all revision of the Society's Constitution and By-laws. This was concluded with Council record at its first meeting approving the revised By-laws. The new By-laws incorporate all of the essential material previously in the By-laws together with all procedural matter transferred out of the Constitution.

At the June meeting, Council approved the committee's report concluding a number of matters which had been long under study. These included:

Honor for the President at Term Completion,

Committee Projects involving Funds,

Non-resident Section/Chapter members,

Research Fund Raising,

Lighting Exhibits.

No changes were recommended in any Society procedure or policy stated in the Manual of Procedures and Policies, since the procedures affected by the committee report were incorporated directly in the related Society By-laws. One subject in the committee's final report, "Competitive Awards," was referred back to the committee for further study and report.

Management

During the past year the Council of the Society held four meetings to discuss and act upon the reports of officers and committees. The five national officers, as the Executive Committee of Council held seven meetings, two just before Council meetings. In addition, routine reports were approved in two months by Executive Committee letter ballot.

At each of the meetings of Council and the Executive Committee, regular reports from the principal Standing and General Committees were received and acted upon. At each Council meeting, reports were presented by the Technical Director on the technical program, and specific technical committee reports were acted upon as listed below.

Headquarters Organization — With the beginning of the fiscal year, Council put into effect the Headquarters re-organization plan adopted late in the previous administration. Acting in his new capacity as Managing Director, A. D. Hinckley directed his efforts toward the principal objectives of more efficient Headquarters operation, direct services to the officers and Council, long-range planning, and more field service. Also according to the new plan, John K. Michel was selected as Office Manager-Membership Secretary. In this capacity he assumed many of the duties previously carried by the Executive Secretary, with the latter position being eliminated.

Headquarters Location — From the base of Council's 1958 decision that the Society Headquarters remain in New York City, the Managing Director initiated studies as to the feasibility of the Society taking space in the projected new United Engineering Center. Beginning in February, the Council and its Executive Committee gave continued attention to the subject leading to Council's final action in June "that the Society accept the invitation of the United Engineering Trustees, Inc. to become an Associate in the United Engineering Center, participating in the benefits and assuming the obliga-

Comparative Balance Sheet as at September 30, 1959, and September 30, 1958.

ASSETS		September 30, 1959		September 30, 1958
General Fund				
Cash in banks and office		$ 32,494.56		$ 31,637.39
Accounts receivable		20,698.52		10,048.49
Accrued interest receivable		.....		35.41
Inventories		39,591.56		6,634.90
Furniture and fixtures (nominal value)		1.00		1.00
Deferred charges				
Production costs, ILLUMINATING ENGINEERING *Handbook*, 3rd Edition		12,987.84	$ 8,474.80	
		.....	[a] 29,006.25	37,481.05
Prepaid Expenses:				
Advances to Sections and Chapters		.....	[b] 3,456.09	
Travel expenses—Headquarters Staff		1,925.00	2,225.00	5,621.09
TOTAL		$107,698.48		$ 91,519.33
Reserve Fund				
Cash in banks		$ 8,229.06		$ 25,881.47
Marketable Securities, at cost				
Bonds	$25,383.76		28,934.01	
Preferred stocks	60,065.00		60,065.00	
Common stocks	56,651.18	142,099.94	35,448.52	124,447.53
TOTAL		150,329.00		150,329.00
TOTAL ASSETS		$258,027.48		$241,848.33

LIABILITIES, SURPLUS AND RESERVE	September 30, 1959		September 30, 1958
General Fund			
Liabilities:			
Accounts payable	$ 8,769.64		$ 1,820.63
Deferred Income:			
Dues collected in advance	.....	$ 705.47	
Subscriptions to publications received in advance	.....	5,371.95	6,077.42
Surplus	98,928.84		83,621.28
TOTAL	107,698.48		91,519.33
RESERVE FUND BALANCE	150,329.00		150,329.00
TOTAL LIABILITIES, SURPLUS & RESERVE	$258,027.48		$241,848.33

[a] Project completed. Production costs applicable to unsold books are included in inventory.
[b] In accordance with change in the Society's accounting, all advances were charged to expense during the year.

NOTES: In accordance with change in the Society's accounting, all dues payments from members and subscription sales are reflected as income in the year received.
Balance sheet at September 30, 1958 was rearranged for comparative purposes.

tions of the new Center on an equal basis with other Associate Societies."

As part of its agreement as an Associate, Council acted for the Society in June, agreeing to solicit the membership for contributions to the cost of building the new Center. At the end of the fiscal year plans were under way for the fund-raising activity to be started in October toward the objective of securing a total of $75,000 as the Society's voluntary quota in the United Engineering Center Member Gift Campaign. The Headquarters staff also had developed preliminary plans as to the office arrangements in the new building.

School Lighting—During nine meetings in the course of the year, Council and its Executive Committee gave consideration to the Society's pronouncements on School Lighting. At the January meeting, action was taken to accept for publication in the *IES Lighting Handbook* the School Lighting Committee's recommendations of definite illumination values for school tasks and areas. At this and other meetings, reports were received concerning the deliberations of the Joint Task Committee (Society representatives together with the American Institute of Architects and the National Council for Schoolhouse Construction), which was working toward a revision of the American Standard Practice for School Lighting, 1948. At several meetings, members of Council urged the expediting of the American Standard revision, and in April took action to approve the preparation of a statement over the President's signature outlining current progress in the 1948 American Standard revision, this statement to be available for circulation with a packet of school lighting material reprinted from the *Handbook*.

With this filling the gap until the publication of a revised Standard Practice or Guide, the Council also acted to urge the School Lighting Committee toward early completion of the revision task.

Illuminating Engineering Research Institute—Council and its Executive Committee continued during the past fiscal year active consideration of the financing of the Research Institute program. Considerable concern was expressed at the December meeting as to the effect of the Trustee's fund-raising campaign on the regular support given the Society and the research program through the Society's Sustaining Members. This resulted in agreement on steps clarifying the relation of the IERI and the Society in this activity. In a related development the President appointed a Task Committee on Research Financing, Kirk M. Reid, Chairman. At the close of the fiscal period, this committee was well along in its task of determining how the long-range financial needs of the IERI may be met.

Beginning with the October meeting, consideration was also given to the procedures first set up in 1947 whereby Headquarters administrative, secretarial and clerical services are supplied by the Society to the Research Institute at no cost. Discussions of this subject revolved around the intimate relation existing between the research program and the Society's technical committee work. Active consideration of the inter-relation between the Society and the Illuminating Engineering Research Institute continued throughout the year, and this was among the subjects referred to the Managing Director for study as to any further needed statements of policy.

Technical Committee Reports Approved—Official action was taken by Council in connection with the following reports of technical committees during the year.

Testing Procedures Committee
Guide for Photometric Measurements of Mercury Lamps (Minute No. 47b—12/11/58)

Progress Committee
Reaching for the Sun (Minute No. 52—12/11/58)

Nomenclature Committee
Illuminating Engineering and Photometric Standards. (Further recommendations on nomenclature covering word changes to formerly approved material, and a new section on light sources.) (Minute No. 83b—2/12/59)

Residence Lighting Committee
Outline for a Training Program (Minute No. 83c—2/12/59)

Testing Procedures Committee
Practical Guide to Colorimetry (Minute No. 151c—6/18/59)

Testing Procedures Committee
Addendum to Guide for Life Performance Testing of Fluorescent Lamps (Minute No. 151d—6/18/59)

Store Lighting Committee
Recommended Practice for Outdoor Parking Area Lighting (Minute No. 151e—6/18/59)

Publications

One of the Society's major services is its publications program. This is a vast operation which serves as the Society's "voice" to its members and to bring the Society to a large segment of the public.

The program is under the direction of the Publications Committee, Dr. R. M. Zabel, Chairman, and is carried out at Headquarters by Ruby Redford, Editor, and Clayton E. Ellis, Advertising and Sales Promotion Manager, and their staffs. The committee held six full-day meetings during the year, together with the staff, in the development of the financial, business and publication details of the program.

(a) ILLUMINATING ENGINEERING, the Society's monthly magazine, continued its editorial aim in presenting major developments in lighting, including articles on good current practice, features of current interest, technical developments in all phases of illumination, the reports of the Society's technical committees, and industry news.

Circulation of the magazine has reflected its usefulness to many nonmembers in the architectural and consulting fields. Some 3083 copies are currently being purchased monthly on a subscription basis. The popularity of one issue, June, 1959, required an additional 4000 copies printed to meet the pre-publication demand for copies.

(b) Reprints from ILLUMINATING ENGINEERING further reflect the value of its editorial material. During the past year, reprinted material promoted and sold by the Publications Sales Office included:

Recommended Levels of Illumination (Reprinted from August 1958 issue)	23,630
Technical Committee Reports	13,078
Individual papers, articles	59,235
Lighting Data Sheets and Packets	
Complete Sets	4,723
Individual Sheets	18,700

TABLE V—Page Content of ILLUMINATING ENGINEERING October, 1958 - September, 1959

	Number of Pages Published
Conference Papers, Abstracts and Discussion	303
Technical Committee Reports	51
President's, Vice-President's and General Secretary's Reports	26
Other Technical Articles	82
Illuminating Engineering Research Institute Reports	68
Application Articles	180
Data Sheets	41
Lighting News	128
Editorials	22
Committee Personnel, Officers, Sustaining Members	37
Advertising	434
TOTAL	1372

(c) *IES Lighting Handbook*, Third Edition, was completed during the past year, and its promotion and sale is now a major project of the Publications Committee and in particular, the Advertising and Sales Promotion Manager. As of the end of the fiscal year, a total of 10,003 copies of the Third Edition Handbook had been sold.

(d) Advertising in ILLUMINATING ENGINEERING has continued to contribute substantially to the Society's income.

Illuminating Engineering Research Institute

The Institute's program has continued actively this year. From a list of nominees approved by Council, the Institute's Board of Trustees took action to have the following personnel serve in the administrative and technical operations of the Institute:

Board of Trustees
A. F. Wakefield, Chairman
Franklin M. Foote, M.D., Treasurer
Conrad Berens, M.D.
O. R. Doerr
Willard E. Hennes
Kirk M. Reid
George J. Taylor

Research Executive Committee
E. M. Strong, Chairman
H. F. Davidson
G. A. Fry, Ph.D.
Leonard C. Mead, Ph.D.
Robert H. Reed
R. M. Zabel, Ph.D.
C. L. Crouch, Secretary

According to the Trust Agreement, the Secretary, C. L. Crouch, submitted to Council progress reports during the year in addition to the Institute's 1958 Annual Report. Progress on specific projects is as follows:

Research on Visual Performance and Quantity of Illumination (No. 30-B-C-D-E-F)—The eight-year research findings of Dr. H. R. Blackwell (Ohio State University Research Center), published in the June, 1959 issue of ILLUMINATING ENGINEERING, present a new scientific method for determining recommended illumination levels for specific visual tasks, based upon visual performance criteria.

Dr. Blackwell's continuing researches (No. 30-G-H-I) will include measurement of school tasks and study of oculomotor functions, development of a prototype Visual Task Evaluator for field use, continuing field task simulator work to establish field factors for various types of tasks, and development of instruments for studying illumination requirements of older workers and the visually handicapped.

Roadway Visibility Studies (No. 30-G-1)—At the request of the IES Roadway Lighting Committee, Dr. Blackwell and associates are making measurements directed toward determining how much light is needed on highways at night to see obstacles in time to stop a vehicle safely when traveling at representative speeds. These data will be helpful in revising the Society's "Recommended Practice for Roadway Lighting."

Visibility in Fog (No. 47-C)—A second fog demonstration was held (at the Ohio State University Research Center) where turnpike, roadway and aviation authorities viewed the progress of evaluating increase of visibility through fog. It has been found that visibility is greatly improved with the use of downlights and sidelights. Studies are continuing.

Disability Glare Meter (No. 58)—A portable meter designed by Dr. Glenn A. Fry of Ohio State University, who furnished the unique entrance optics, has been completed by Dr. Blackwell and his associate Mr. B. S. Pritchard by developing a suitable weighting filter and attaching the whole to a photoelectric brightness meter designed and built by Mr. Pritchard. Dr. Blackwell and Mr. Pritchard are currently using the meter in making roadway measurements for Project No. 30-G-1 mentioned above.

Glare from Very Large Sources (No. 59-B)—Dr. R. G. Hopkinson, Building Research Station, Garston, England, began this study at his overseas laboratories two years ago. With the advent of large picture windows in homes and glass-sided buildings, he extended his studies (under IERI auspices) to sky-glare and glare from large luminous areas of electrical installations. Under Dr. Hopkinson's direction parallel experiments are being conducted at Cornell University by Robert C. Bradley. A formal report on the first phase has been completed and is expected to be published this coming year.

Effect of Transitional Adaptational Changes Upon Visual Performance (No. 63)—This project is being conducted at the University of Rochester under the direction of Dr. Robert M. Boynton. It is designed to develop a basis for suitable brightness ratios in interiors. Preliminary results indicated a loss of visual performance immediately upon encountering higher and lower brightnesses than previously adapted brightness.

Loss of Contrast Due to Specular Reflection (No. 52 by Prof. D. M. Finch at the University of California and No. 65 by J. M. Chorlton, Toronto Board of Education and H. F. Davidson, Curtis Lighting of Canada, Toronto)—These two projects have investigated methods of measuring the degree of loss of contrast under given lighting systems of pencil work, printing material, ink and papers. Reports on the two projects are published in the August, 1959 issue of ILLUMINATING ENGINEERING. Earlier they were presented as a joint paper before the International Commission on Illumination (CIE) in June, 1959 at Brussels, Belgium.

Frequency and Duration of School Visual Tasks (No. 68)—This is a pilot study which the Toronto Board of Education is conducting to determine the man-hours and facilities which would be necessary to engage in a comprehensive survey of the visual tasks in schools, their segregation, duration and frequency. The Educational Facilities Laboratories of the Ford Foundation have shown an interest in this work.

Programming IBM Computers for Calculating Chromaticity Coordinates (No. 69)—This is one part of a three-part cooperative research with the National Bureau of Standards and the Department of Agriculture. The joint efforts now make it possible to compute CIE chromaticity coordinates for samples under light sources having lines of spectral energy output by using programming cards for computer calculations.

Study of Lighting Principles Used to Reduce Reflected Glare from Ceiling-Mounted Luminaires (No. 70)—This work is being done by Dr. Blackwell and is expected to result in a technique for measuring small degrees of losses of contrast due to specular reflectance. A progress report was presented at the 1959 IES National Technical Conference and it is expected that this will be published subsequently.

In addition to the studies reported above, five new proposals have been received and are being processed.

The financial support for the research program has in the past come mainly from the Society. In order for

the Institute to carry on its present program without curtailing the progress being made to obtain the required answers, it was realized that considerably more funds would be needed than what the Society was able to provide. Thus the Institute's Board of Trustees launched a campaign for contributions of $150,000 over a two-year period. Two-thirds of this amount has been received or promised and further large contributions are expected in the near future. In the interest of promoting the research program, the Society has appointed a special task committee "to determine how the long-range financial needs of the IERI research program may be met."

Standing Committees

Six standing committees are set up by Constitutional provision and reference has been made earlier in this report to the work of three of these, Council Executive, Finance and Publications. Reports for the remaining three follow:

General Board of Examiners

H. E. D'Andrade, Chairman

The Board held twelve meetings at Headquarters for the approval of applications for election to Member grade, or for transfer to Emeritus or Retired membership. There was a large volume of applications, with favorable action recommended to Council by the Board in 284 cases.

The Board also re-edited the Reference Form which goes to those who are asked to sponsor individual applications for membership. The new form is expected to be a more effective guide for sponsors and an aid to the Board in its work of evaluation.

Board of Fellows

Edward Rambusch, Chairman

The Board met in June to consider nominations for transfer to Grade of Fellow. Prior to the meeting each member was provided with information regarding all candidates, so that the members of the Board had opportunity to study the candidates' qualifications before the meeting.

Eight nominations for the Grade of Fellow were approved and recommended to Council for action at its June meeting, along with suggested citations briefly describing the contributions of the nominees.

Papers

Floyd Sell, Chairman

From a total of 68 proposals for papers submitted, the committee tentatively approved 38. After reviewing the completed papers, the committee selected 36 for presentation at the San Francisco Conference. Three invited papers were added to make a total of 39 for the program. It was necessary to continue the practice of holding parallel sessions in order to accommodate this number of papers in the time available.

General and Task Committees

The General Committees of the Society are charged with the operating functions not handled by the Standing Committees, and not pertaining to the preparation of reports on scientific and engineering subjects. The work of the Regional Activities Committee and of the Task Committee on Research Financing has been given in the preliminary part of this report. Reports for the balance of the General and Task Committees follow:

Advance Planning

J. D. Mitchell, Chairman

The committee held two meetings this year and exchanged considerable correspondence. The discussions have dealt mainly with the following subjects:

1. Effectiveness of the Society in advancing the theory and practice: So far these discussions have been principally in regard to the effectiveness of the National Technical Conference.

2. Effectiveness of dissemination: How can ILLUMINATING ENGINEERING be made more effective? How can the work of the Public Relations and Information Committee be made more effective?

3. Council Make-up: Are changes in the make-up of Council needed to make it more effective?

There have been some excellent discussions on the above subjects which will be continued in the coming year.

Advisory Board to the President

J. B. Browder, Chairman

The Board met several times and submitted to the President and President-elect recommendations on organization, chairmanships, and personnel of committees.

Allied Arts

J. D. Whitnell, Chairman

The international character of the Allied Arts activity has been preserved two-fold this year. The University of Manitoba School of Architecture again conducted a program emphasizing lighting and decoration, piloted by the Winnipeg Chapter. Interesting drawings were submitted by the day and night architectural division of Waseda University of Japan.

In the United States, three new additions to the slowly-but-surely growing ranks were Harvard and Massachusetts Institute of Technology, sponsored by the New England Section, and the University of Florida, under the guidance of the Suwannee River Chapter. The Florida activity is not yet a full-fledged program.

As in previous years, the drawings exhibited at the San Francisco National Technical Conference represented literally hundreds of students' efforts in Allied Arts programs in some 24 universities. It was more a representative exhibit of their local work than a representation of winners of a national contest. The primary reason for this is that some schools do an eight-hour problem, others take five to ten weeks.

Board of Nomination

R. F. Hartenstein, Chairman

In accordance with the Constitutional provisions and following the procedure adopted by Council, the Board, consisting of three Past Presidents of the Society and representatives from each of the eleven Regions, reviewed the records of the candidates that were submitted by the respective Regional Nominating Committees. As a result of these reviews, the Board then prepared a nomination ticket that contained the names of those deemed best suited to serve as officers and directors in the positions to be filled at the ensuing election.

Constitution and Procedures

R. F. Hartenstein, Chairman

At its meeting in February, the committee again reviewed the letter ballot approving revised By-laws as requested by several members of Council so as to clear up some minor changes suggested by them. The committee then submitted to Council on February 12 the revised By-laws with the minor changes included that were approved by the committee. The By-laws already having been approved by letter ballot were

then given final approval by Council.

At its meeting in Chicago in April, the committee considered all the other items that were pending and presented to Council in June its final report for the year. The items on which the committee prepared recommendations to Council, subsequently approved, included the following:

Honor for the President at Term Completion—The committee discussed this proposal of the Advance Planning Committee several times. At the National Technical Conference in Toronto in 1958, the Chairman, at the request of the committee, talked with most of the Past Presidents there regarding this matter. In view of their opinions, it was recommended to Council that no action be taken on this.

Committee Projects Involving Funds —This policy matter was handled in the revision of the By-laws (refer to Art. IV (b) Section 4).

Research Fund Raising—This policy matter was taken care of in the new By-laws (refer to Art. IV (b) Section 4).

Non-Resident Section or Chapter Members—This policy was also handled in the revision of the By-laws (refer to Art. IX (d) Section 2).

Lighting Exhibits—It was the opinion of the committee that the present policy regarding lighting exhibits at the National Technical Conferences should remain as is, which reads as follows:

"No product exhibits or displays shall be held in connection with the Technical Conferences unless specifically approved by the National Technical Conference Committee and the Council of the Society. Any exhibits shall be of an educational nature only and consist of charts, photographs, instruments and laboratory equipment."

Therefore, there was no new policy statement to be made. However, regarding Section, Chapter and Regional Conference lighting exhibits, the committee recommended to Council that this matter be referred to the Regional Activities Committee for their consideration as a local problem.

Defense Coordinating

J. W. Bateman, A. F. Wakefield, Co-Chairmen

This committee continues to provide means for defense agencies to use professional counsel in illumination. Sixteen projects have been handled since the committee was established.

Historical

S. B. Williams, Chairman

This year has been spent largely in reviewing the contributions this committee might make to the Society that would have a permanent value. Many suggestions have been received but they either entailed heavy expenses, such as permanent fixed and mobile historical exhibits, preparation of histories or development of a comprehensive library; or they added little or no worthwhile value to the Society.

S. G. Hibben, Past-Chairman, as a continuing member of the committee, has supplied articles of historical note to ILLUMINATING ENGINEERING which have been well-received. Special projects, at the request of Society officers, have been reviewed and suggestions made. These included the George Stickney Memorial Fund. Because of geographical dispersion of this committee, no meetings were held. Everything was done by correspondence.

Lighting Service

C. W. McCormick, Chairman

Contest Operation 1958-1959 — The rules for Section and Chapter, Regional and National Contest as revised (1958-1959) were printed and distributed through Headquarters. These again were printed by photo-offset in pamphlet form. The committee at an early meeting discussed the 1959 National Contest in San Francisco and decided to permit contestants who could not attend or use proxies, to put their entry on tape and forward it with slides, etc., to the National Conference. A standard form for Regional Vice Presidents reporting Regional MMILJ for the National Contest was agreed upon. The committee concluded the year by conducting the National MMILJ Contest in the Lighting Service Forum at San Francisco in September, 1959.

Contest Operation, Future — The committee studied the current rules and recommended that they be altered. The proposed standard display form for Regional and National Competition is described and shown in a photograph in the Lighting Service Committee Annual Report for 1957-1958. The revised rules are being submitted for consideration by the 1959-60 committee.

Committee Scope and Activity, Future—The committee considered steps for dissemination of lighting applications and information to architects and consulting engineers. It was recommended to Council that this could be done through architectural and engineering trade journals, especially those which are read by architects.

A National Technical Conference Application Day was studied and a suggested outline was presented to Council.

The committee discussed the function and scope of the Lighting Service Committee and its association to MMILJ Contest. It recommended to Council that an MMILJ Contest subcommittee or a separate committee be set up to relieve the committee of this work to permit it to consider other phases of its scope. A task committee to study MMILJ Contests was appointed by President Taylor. J. C. Wilson was appointed as Chairman.

Medal Award

R. F. Hartenstein, Chairman

The committee met in Cleveland and reviewed the qualifications of all the candidates that were submitted by Sections and Chapters of the Society and also by committee members. A ballot was taken of those present and a letter ballot was received from the absentees, which resulted in the unanimous selection of Dr. N. A. Halbertsma of Holland to receive the 1959 Medal Award.

The Citation that accompanied the nomination to Council described Dr. Halbertsma's accomplishments. He was a Professor of Illuminating Engineering at Utrecht. He is a Member Emeritus of the Illuminating Engineering Society. He helped in the founding of our sister organization in The Netherlands. He also is an Honorary Member of the French Association. He is a broadly experienced contributor to theory and practice of illumination and has been a dynamic Ambassador of Light to many lands. Dr. Halbertsma was President (1939-1951) and is now Honorary President of the Commission Internationale de l'Eclairage. He is an able linguist, highly knowledgeable and discerning. He is a talented speaker and is ever ready with a message appropriate to the occasion. He has for three decades been a commanding international figure and a potent unifying force.

Membership

J. C. Forbes, Chairman

The 1958-59 Membership Committee was organized on the basis of a representative from each Region from candidates suggested by the Regional Vice Presidents. In addition, several members-at-large were appointed by the Chairman. A goal of 10,000 members was established with the approval of the President, George J. Taylor. Quotas for new members were suggested to each Section and Chapter and, in most cases, these were accepted as a challenge by the officers.

To assist the local units in attaining their goals, a series of contests were established using a net gain figure as the basis for judging performance, Region *vs* Region; Section *vs* Section, nationally; Chapter *vs* Chapter, nationally; Sections and Chapters against each other within each Region. Winners in the 1958-59 membership campaign, showing per cent net gain, were announced in San Francisco, California, on the occasion of the National Technical Conference, as follows:

Region vs Region

	Per Cent Gain
Canadian	20.9
South Pacific Coast	15.0
South Central	9.7

Section vs Section

San Diego	62.0
Western New York	28.4
British Columbia	25.0
Miami Valley	21.9
New Jersey	20.8

Chapter vs Chapter

Quebec	139.0
Yosemite	64.0
San Jose	63.4
Winnipeg	47.3
Chinook	39.2

During the year, the Council asked for a report from the Membership Committee on organization changes or programs that could be undertaken to improve the effectiveness of the membership activity in the future. A special subcommittee was appointed and at the completion of their work, the report was submitted to Council. In developing this report, it became obvious that the success of a membership program is so dependent on all the activities of the Society that the suggestions of this committee must be coordinated with many other suggestions from the rest of the Society. For instance, the largest percentage gains by Sections or Chapters in any one year usually result from the establishment of new Chapters.

The chairman is grateful for the support he has received from the Committee members and the headquarters staff.

For the record, the final membership report is as follows:

Membership, 10-1-58	8983
New members and reinstatements	1505
Losses (resignations, dropped delinquents)	956
Deceased	45
Net Gain	504
Total Membership, 9-30-59	9487

National Technical Conference

Charles L. Amick, Chairman

The committee received and accepted an invitation from the Michigan Section to hold the 1963 National Technical Conference in Detroit, and this selection has since been approved by Council. Following the practice established in recent years of selecting locations approximately five years in advance, the site of the 1964 Conference will be determined in the next few months following the approved pattern of choosing specific Regions at certain intervals. Locations for the next few years are as follows: 1960—Pittsburgh, 1961—St. Louis, 1962—Dallas, 1963—Detroit.

The Task Committee, established to make a long-range study of the National Technical Conference and its relation to the total Society program, prepared questionnaires to sample the preference of members regarding time, location, type of program, and other factors which apparently determine interest in the Conference. The work of this special committee will continue, with a final recommendation expected during the coming year.

Public Relations and Information

W. A. Dalrymple, Chairman

Planning for the year's program was the subject of the two committee meetings held at the beginning of the year. Expanded programs were developed during the course of the year and presented to the national officers for discussion at their meetings. The 1958-59 committee program was carried out mainly through the professional services of Public-Relations Counsel, Herb Cornell. He consulted with officers, staff, and committees and prepared for release, press copy in connection with the Society's national program, and the program at Regional Conferences and the National Technical Conference in San Francisco.

In addition to the committee program, public relations with the individual and Sustaining Membership were developed through ILLUMINATING ENGINEERING and numerous contacts with national officers and Headquarters staff. The year's outstanding research and application reports were a most valuable program subject at numerous meetings addressed by national officers and C. L. Crouch, Technical Director, and including such groups as the Edison Electric Institute Sales Conference, Industrial and Commercial Section, and the Building Research Institute. The sales promotion circulated by C. E. Ellis, Advertising and Sales Promotion Manager, for reprints, the new *IES Lighting Handbook* and ILLUMINATING ENGINEERING, reached a very large number of persons in areas related to the lighting field, furthering the Society's public relations considerably.

Residence Lighting Forums

Virginia Skinner, Chairman

Three committee meetings were held in New York at Society Headquarters to plan for: (1) the program at the San Francisco Conference, (2) the Forum Slide Library which is being assembled for Forum programs, (3) publicity and exchange of information pertaining to successful programs and activities.

New Forums—Three new Forums were organized within the past year. New groups have been formed in Kansas City, San Francisco and Toronto. The Chicago Forum which had been inactive for some time was reorganized this January. A new Forum is expected by the Maryland Section in early fall.

Forum Slide Library—One of the most important achievements of the year has been the establishment of a Forum Slide Library. This library is made up of the slides and data from the Residential Division of the MMILJ Contest. These entries are now available at Society Headquarters to be loaned to the various Forums. The slides are especially attractive and the accompanying illumination data are specific and complete.

Special Bulletins to Forums on Membership and Programs—Two "idea letters" were sent to the Forums. The first letter, prepared by Ruth Morris, was entitled, "How to Increase Forum Membership" and listed seven different ways of obtaining new members. The second letter in the form of a bulletin summarized all the possible programs available to Forums.

Special Activities—The Kansas City Forum and the Kansas City Power &

Light Co. co-sponsored the Academy of Lighting Arts in this area. These study clubs were held during the spring months. Twenty-five classes were held with a total attendance of 561. A great deal of enthusiasm and interest for residence lighting was created through this activity.

Forum Membership and Attendance —Two Forums had a marked increase in attendance. The St. Louis Forum showed an increase of 31 per cent in attendance over last year and the Texas Forum in Dallas had an attendance increase of 18 per cent. The total membership and total number of meetings held was naturally higher because of the additional groups organized this year. The New York Forum has the largest membership with 116 members. Attendance and membership figures for all the Forums are given below:

Forum	Membership	Meetings	Attendance
Arizona	50	4	152
Atlanta	103	6	304
Capital	55	3	244
Chicago	29	4	367
Golden Gate	20	1	125
Kansas City	42	3	76
Michigan	103	5	207
New York	116	8	437
St. Louis	50	6	314
Texas	64	5	287
Toronto (new group)			
Twin City	49	4	258
Utah	50	(Inactive, no report)	
	731	49	2671

Sustaining Membership

W. Warren Booth, Chairman

The committee continued in its service to the important relations between the Society and its Sustaining Members, strengthening the lines of communication and giving recognition to the financial and membership support which provides the means for expanding the Society's services to the whole membership and to the public. Locally, special effort was made to have official representatives and others in Sustaining Member organizations attend meetings, or have Official Representatives recognized at one special meeting; at Regional Conferences, to secure company support in promoting attendance, and to recognize Official Representatives at some Conference function.

The Section and Chapter program continued successfully in its service to present Sustaining Members, and in the addition of a sizable group of new members.

The final figures for the year reflect not only the gains achieved by the Sections and Chapters, but also the losses due to resignations and dues decreases. The closing figures are shown in comparison with those for recent years.

	Members	*Dues Income*
1953	334	$40,735
1954	336	40,635
1955	334	43,391
1956	414	63,893
1957	452	66,402
1958	448	64,815
1959	464	65,505

Tellers

Arthur L. Davis, Chairman

In accordance with Constitutional provisions, the committee met on May 26th following the close of the election ballot and counted the vote both on the National and Section offices. In this the committee had the customary assistance of Headquarters personnel both in the preparation of the forms and reports, as well as in the opening of the ballots and the making of a preliminary count.

Trustees — Headquarters Retirement Plan

M. N. Waterman, Chairman

The Trustees of the Plan held their regular annual meeting at the time of the National Technical Conference in San Francisco. The customary formal record was made covering the operation of the Plan during the fiscal year just completed.

Joint Task Committee, IES-USPHS

J. F. Persons, Chairman

The report of this Task Committee, "How to Make a Lighting Survey; A Vision Survey," was accepted as a progress report by Council in 1955. Following a survey which indicated a sufficient demand to justify publication, the draft was revised to bring it up to date, technically. Publication in pamphlet form is anticipated in the near future.

Technical Committees

Aviation and Signal

M. A. Warskow, Chairman

The Aviation Committee's group was reorganized to form one coordinating committee—the Aviation and Signal Committee—with the following three committees under its aegis:

Aircraft Lighting — Warren Hulke, *Chairman*

Aviation Ground Lighting—R. J. Stefany, *Chairman*

Signal Lighting — J. F. Angier, *Chairman*

The Aviation Ground Lighting Committee held a conference on November 18 and 19 at Dow Air Force Base, Bangor, Maine. The conference provided the 100 members and guests in attendance an opportunity to bring themselves up to date on ground lighting developments, on plans for future research, and an opportunity to discuss these. They made a field inspection of the newest in ground lighting—high intensity, "narrow gauge" flush lights in the runway pavement at Dow Air Force Base, and witnessed the testing of the system in near zero-zero conditions by Air Force bombers and Century fighters. The committee has completed its first recommended practice for "Airport Service Area Lighting" prepared by the subcommittee on Airport Service Area Lighting. It is anticipated that Council approval will be given to this in early fall.

The Aircraft Lighting Committee, to a major extent, is attracting new membership from West Coast aircraft manufacturers. This committee organized a very successful conference for April 14-15 in Hollywood, California. The 100 members and guests heard and participated in a series of papers and discussions on basic considerations and progress in aircraft lighting. These involved presentations and discussions on such basic items as visual fatigue and efficiency, and reports on the state of the art in general applicable fields, such as fluorescent lighting.

Signal Lighting Committee is endeavoring to compile basic information on signal lighting and will continue this effort.

Both the Ground and Aircraft Lighting Committees intend to continue with annual conferences as this seems to be a desirable means of advancing each committee's technical fields.

Color

R. C. Allison, Chairman

A "Recommended Treatise for a Guide on 'Color and the Use of Color by the Illuminating Engineer'" was submitted by the committee to the Technical Office for comments. The Technical Office solicited comments from three prominent colorists and transmitted these to the committee together with its own comments.

Daylighting

J. W. Griffith, Chairman

A meeting of the committee was held at the Toronto National Conference. At this meeting, Dr. Ralph Hopkinson gave a brief review of the current research being conducted on the glare effects of large area sources at his Research Station in England and at Cornell University. R. W. McKinley, Chairman, Subcommittee for Revision of the *Recommended Practice of Daylighting*, reviewed the progress of the subcommittee and submitted it to the full committee for final approval.

A second meeting of the committee was held on May 20, 1959, at the Statler Hotel in Cleveland, Ohio. The "New Recommended Practice of Daylighting" was reviewed and minor changes inserted before submitting it to Council for approval.

The Subcommittee on the Availability of Daylight was reactivated with E. M. Linforth as chairman. The coordinating subcommittee chairman, Dr. R. A. Boyd, reported that no matters requiring the attention of his subcommittee had arisen as yet in the current year.

Design Practice

George W. Clark, Chairman

Committee activity was limited to final preparation of copy for Section 9 of the *IES Lighting Handbook*, Third Edition. Action was initiated to review photometric data development as it affects coefficients of utilization.

Education

Alston Rodgers, Chairman

After some final finishing touches, the activities booklet for school science classes, "Laboratory Activities with Light," was released for publication in April.

Carl Zersen continued to coordinate the work of the subcommittees revising the Society's lighting courses, to be sponsored by Sections and Chapters. It is anticipated that R. E. Wozniak and his subcommittee will complete final copy of the "Lighting Fundamentals Course" for submission to Council early in the next fiscal year. The first draft of the "Advanced Lighting Designs Course" has been completed by R. R. Lusk and his subcommittee, and it is being reviewed by the committee members.

First draft of the brochure for college students, "Opportunities in Illuminating Engineering," is scheduled for review by the committee in September.

Handbook Revision

John J. Neidhart, Chairman

With the on-schedule publication of the Third Edition of the *IES Lighting Handbook* in March, 1959, the current Handbook Revision Committee has completed its assignment. Following publication, however, the Committee met to review the work of producing the Third Edition and from experience outlined its recommendations for the preparation and publication of future editions. As a result of this meeting, the committee has recommended to Council the establishment of a permanent Lighting Handbook Committee to keep reviewing the effectiveness of the Third Edition and to recommend and execute the next revision when it seems advisable.

IES - ASAE

Morris H. Lloyd, Chairman

The committee held its first meeting for the year 1958-59 in Buffalo last October following the Inter-Industry Farm Electric Utilization Conference. At that time it was decided to gather as much information as might be available on regulations issued by various states and political subdivisions which might have a bearing on farm lighting. Professor D. E. Wiant of Michigan State University has been collecting this material and most of it relates to regulations of various health departments concerning the lighting of dairy barns and milkhouses.

At this same meeting, J. P. Ditchman suggested that the committee get in touch with Dr. Blackwell at Ohio State University to see if he would undertake some basic studies in the lighting requirements of several farm tasks. The committee feels that some studies along this line should be made before there is any attempt to prepare any further recommendations on the lighting of farm buildings.

IES - ASHRAE

A. T. Jorn, Chairman

The committee was largely inactive during the year but the Chairman made comments relating to the future work of the committee.

Institutions

R. D. Bradley, Chairman

The Church Subcommittee under George Shoemaker, Chairman, has continued active revision of the report "The Lighting of Churches." It is anticipated that this will be submitted to Council in the next fiscal year.

The Dining Areas Subcommittee under George Gilleard, Chairman, has been inactive during the year.

The Hospital Subcommittee under N. L. Griffin, Chairman, has made a survey of dental recovery rooms in relation to the illumination levels being used and members of the committee are continuing investigation of the lighting of patients' rooms.

The Hotel Subcommittee under Professor C. I. Sayles, Chairman, having finished its assignment last year, has been inactive.

Light Control and Equipment Design

J. J. McLaughlin, Chairman

The committee has a draft of a report on light characteristics of acrylics which they are reworking into a form similar to the "Recommended Light Characteristics of Polystyrene Used in Illumination."

Light Sources

G. A. Freeman, Chairman

Two meetings of the committee were held during the period. Various projects that had been deferred, when full attention had to be given to Handbook revision, were reactivated and several new projects started. The systematic collection of lamp data such as for future Handbook changes has been initiated on a continuing basis.

Four subjects for the "Question and Answer Page" of ILLUMINATING ENGINEERING have been prepared. Two suggestions from this committee resulted in active projects in the Testing Procedures Committee. A paper has been prepared for ILLUMINATING ENGINEERING also as a result of a suggestion from this committee.

The subcommittee on Color Rendition, under the chairmanship of Miss Dorothy Nickerson, met several times during the year. They are continuing to make progress on the study of the problem of measuring and specifying the color rendition properties of light sources.

Maintenance

M. L. Trostle, Chairman

The committee continued to distrib-

ute the suggested form "Maintenance Test Data of Lighting Installations" for the collection of data from a great variety of different types of installations. It is hoped that this data can be correlated for obtaining reliable information on maintenance factors in different types of installations.

Motor Vehicle (Exterior)

G. S. Evans, Chairman

Committee is continuing with the organization of their activity.

Nomenclature

Sylvester K. Guth, Chairman

The Committee continued its work on the revision of ASA Z7.1-1942, *Illuminating Engineering Nomenclature and Photometric Standards*. One additional section, 25—Light Sources, was approved by the Committee and forwarded to Council. Also sent to Council was a change from "candles" to "candelas" in order that the IES nomenclature would be in agreement with CIE terminology.

Additional sections, on which work is progressing, include Section 15—Ultraviolet Radiation, Section 35—Lighting Calculations, Section 40—Testing Procedures, and several sections dealing with lighting application terms. In connection with the last item, cooperation of the various lighting application committees has been solicited to insure the completeness of the list of terms and their definitions.

In order to bring our publication in line with current ASA practice, a special study is underway to review the organization of Z7.1. It is hoped that this can result in the arrangement of the material in a more logical order.

A continuing effort is being made to bring Society terminology and definitions into close agreement with reports adopted by the International Commission on Illumination (CIE).

Office

Eric H. Church, Chairman

This committee had two meetings in which they studied and made recommendations to change the present Office Lighting Practice. Final draft will be submitted to Council shortly for their approval.

Progress

E. A. Linsday, Chairman

The committee maintained contact with the art of lighting throughout the world and prepared the yearly review of the achievements in the art of lighting for publication in ILLUMINATING ENGINEERING. This review was given a dramatic presentation as one of the features of the 1959 National Technical Conference in San Francisco.

Public Conveyances — Interior Lighting

E. Boghosian, Chairman

A meeting of the Marine Lighting Subcommittee was held in October, 1958. At this meeting, special problems of shipboard fluorescent lighting were discussed as related to grounded distribution systems.

Quality and Quantity of Illumination, Recommendations for

John J. Neidhart, Chairman

The committee has embarked on a program to develop methods of evaluating or predetermining lighting quality factors. Specific needs have been outlined, and subcommittees on direct glare and reflected glare have been appointed under the chairmanships of Willard Allphin and R. D. Bradley, respectively. Research programs to provide necessary answers have been instigated. All technical committee chairmen have also been asked to provide additional typical visual tasks for quantity of illumination requirement study in the Visual Task Evaluator and, where pertinent, for reflected glare studies.

Residence

William F. Little, Chairman

The committee has completed the two items for which they have been responsible during the year 1958-59, namely "Lighting Keyed to Today's Homes," and "Outline for A Training Program." Both have been submitted to the Council for action.

Roadway

Dana W. Rowten, Chairman

The work of the Roadway Lighting Committee has, as in the past, been delegated to several subcommittees. The chairmen of these subcommittees are requested to report to the main committee their progress at each of two regular meetings. This last year, all the subcommittees have been active, but two have reports of outstanding interest and accomplishment.

The Standard Practice Committee, under the chairmanship of W. H. Edman, has completed a draft of a new and expanded Recommended Practice for consideration by the main committee. This draft may undergo some additional changes before it is approved by committee and Council and becomes ready for submission as a new 1960 Standard Practice.

The Subcommittee on Research, under the chairmanship of D. A. Toenjes, has pursued several projects and can report considerable progress on the researches concerned with pavement surfaces, instruments for various measurements, visibility under fog and most important, the Blackwell research on roadway visibility. Wherever these projects have developed new data, these data have and will be evaluated in the preparation of the proposed new or amended "Recommended Practice for Roadway Lighting."

Members of the Roadway Lighting Committee represented the United States at the meeting of the International Commission on Illumination at Brussels in June.

School

J. M. Chorlton, Chairman

The committee has continued to work through its representatives with the Joint Task Committee on School Lighting consisting of representatives of the American Institute of Architects, National Council for Schoolhouse Construction and the Illuminating Engineering Society. Agreement was reached with the leaders of these delegations on the listings of footcandle recommendations in the Third Edition of the *IES Lighting Handbook*. Members of the Joint Task Committee have contributed drafts of segments for compilation into a near-final draft of a "Guide for School Lighting." It is anticipated that this material will be in such a form that it may be submitted to the Society's School Committee in the near future. The School Committee was informed of the features of this report at a September 9 meeting.

Searchlight

J. P. Latil, Chairman

The committee had a meeting on June 5, 1959, in Salem, Massachusetts. Thirty memberes and guests attended. Four talks were given: "Advances in Pyrotechnics for Space Age Illumination Problems" by Stanley Resnick;

"Carbon Arc Searchlights for Tanks" by Lynn Crim; "New Searchlight with 2500-Watt Mercury Xenon Lamp" by Brent R. Finch; "The Influence of Brightness on Light Source Design" by S. C. Peek.

The chairmen of the subcommittees indicated the progress of their various tasks. The chairman of the Optics Subcommittee distributed a brochure established by his subcommittee entitled "Tabulation of Parabolical Reflectors for Searchlight Use" (June 5, 1959).

Sign Lighting

C. N. Laupp, Chairman

The Committee is progressing in the organization of plans and activities.

Sports and Recreational Areas

Wallace W. Weld, Chairman

A final revision of "Recommended Practice on Sports Lighting" has been submitted to Council. This revision includes practically every sport carried on in this and foreign countries. The Practice has been brought completely up to date and revisions have been made for some of the indoor sports. Each of the recommended layouts following the main text shows the size of the area, location of floodlights, type of floodlights to use, mounting height and footcandles required for different classifications.

A complete table, which refers to these layouts, follows them and gives the various classifications, number of poles and number of floodlights per pole, as well as total number of floodlights required and type of floodlight and lamp size needed to produce the various footcandle levels specified.

There is a section devoted to illustrations on installations which meet IES specifications. Along with these illustrations is shown a layout with pole locations, pole height, number of floods per pole, class and type of floodlight, as well as lamp size and footcandles delivered. Most major sports areas are covered by these illustrations.

Store

Lester Geis, Chairman

Continued work has gone forward on the revision of the committee report, "Lighting for Stores and Other Merchandising Areas."

The Subcommittee on Parking Areas and Service Stations, under E. H. Schaefer, Chairman, submitted the "Recommended Practice for Parking Areas" to Council at the June meeting.

Testing Procedures for Illumination Characteristics

Arthur W. Weeks, Chairman

Two meetings were held, each of which required two full days. The attendance averaged 61 per cent of the committee members. This is a good record considering that the membership extends across the country and includes one member from Canada.

The subcommittees in charge of preparation of guides have been active and progress is reported as follows:

Guide for Electrical and Photometric Measurements of Fluorescent Lamps—G. A. Meyers, Chairman. This subcommittee has been reactivated to include measurements of heavily loaded lamps, and combine two previous guides covering both electrical and photometric measurements. A first draft is in subcommittee. Early presentation to Counvision for submission to the entire committee. Early presentation to Council is anticipated.

An Addendum to Guide for Life Performance Testing of Fluorescent Lamps—Priscilla Presbrey, Chairman, which provides necessary information for life testing of heavily loaded lamps, has been accepted by Council.

Guide for Photometric Testing of Fluorescent Luminaires—G. A. Horton, Chairman. A third draft has been submitted to subcommittee.

Guide for Photometric Testing of Mercury and Incandescent Street Lighting Luminaires—T. H. Leister, Chairman. The first draft has been submitted to the subcommittee.

Guide for Photometric Testing of Floodlights of 10-Degree to 160-Degree Total Beam Spread—J. S. Franklin, Chairman. A questionnaire has been sent to subcommittee to determine the scope of this project.

Guide for Photometric Measurements of Mercury Lamps—J. S. Franklin, Chairman. This has been accepted by Council, and was published in the October, 1959, issue of IE.

Practical Guide to Photometry—R. D. Bradley, Chairman. This project is very active. The first draft will be sent to the subcommittee shortly.

Practical Guide to Brightness Measurements—P. H. Lamson, Chairman. The final draft will be sent to subcommittee and this Guide is very nearly ready for committee ballot.

Practical Guide to Colorimetry of Light Sources—R. P. Teele, Chairman. This was accepted by Council and will be published in IE.

Guide for Interpretation of Test Data and Results—S. F. Downey, Chairman. The interest in this project is shown by the large number of members who have requested membership. The subcommittee has prepared a tentative outline of its scope and aims.

Guide to the Method of Measurement of Fluorescent Lamp Starting—G. A. Meyers, Chairman. An outline of the proposed contents has been submitted and a draft awaits only experimental confirmation of methods.

Guide for Methods and Techniques of Measuring and Reporting Tests of Reflector Type Lamps—Priscilla Presbrey, Chairman. Considerable progress can be reported, and the first draft has been sent to subcommittee.

Three study projects have been set up. These groups are exploring the possibility of preparing guides on the subjects under consideration.

Study Project A—To establish methods of testing heavily loaded lamps and auxiliary equipment with respect to distribution and physical orientation—G. A. Horton, Chairman.

Study Project B—To establish methods of measurement of temperature and drafts with respect to fluorescent lamps and auxiliary equipment—G. A. Meyers, Chairman.

Study Project C—Committee to follow ballast testing techniques—R. D. Bradley, Chairman.

Theatre-Television

Joel E. Rubin, Chairman

The Recommended Practice "Reporting Photometric Performance of Incandescent Filament Lighting Units Used in Theatre and Television Production" was published in the September, 1958 issue of IE.

A subcommittee was appointed to seek ways and means of effecting the widespread adoption of this by non-Society users of such equipment.

Other subcommittees began preparation of research reports on the following subjects: (1) Lighting for Vidicon Camera Installations; (2) Lighting for School Theatres; (3) Theatre and Television Lighting Glossary; and (4) Dimming Device Calibration. It is anticipated that these reports will be completed and published soon.

IES APPLIED LIGHTING COMPETITION

NEW NAME. . . .
NEW RULES. . . .
NEW PRIZES. . . .

IES's popular lighting contest (formerly MMILJ) will be big, new, and professional this coming year. A thorough in-depth study has now been completed on the whole set-up (by J. Carl Wilson, chairman of a special study committee). Their recommendations were further studied (and approved) by Council November 19. Official rules, procedure, prizes and awards are outlined on the following 2 pages. Reprinted copies will be available from all Section and Chapter chairmen and/or local competition chairmen—or from IES Headquarters.

Enter This Year's Local Contest

PURPOSE of the IES competition is to encourage and stimulate IES members to submit a presentation describing an unusually interesting lighting application, which will have interest and value to the Society.

While there are cash prizes and trophies awarded to the winning presentations, it is the purpose of this competition to:

(a) Increase the ingenuity and originality in lighting design.
(b) Add to the Society's library of lighting application information.
(c) Provide members with a unique opportunity to gain public recognition for excellence of lighting design.

OFFICIAL RULES

IES Applied Lighting Competition

This competition is conducted under a uniform set of rules to assure equality and fairness to all participants, regardless of the location of their affiliation. In the case of doubt as to the interpretation of any rule, the decision of the National Committee for the Lighting Competition shall be final.

Competition Responsibility

1. Section and Chapter Competition—The Board of Managers of the Section or Chapter is responsible for the competition, and shall at the beginning of the fiscal year appoint a competition chairman, and set a date for the competition meeting.

2. Regional Competition—The Regional Vice-President in each Region shall be responsible for the operation of the Regional Competition. He may act as Competition Chairman, or have a chairman appointed in conjunction with the Conference Committee. The chairman shall be responsible for all details of the competition, including the handling of publicity, information, timing arrangements with the Papers Committee, appointment of judges and session chairman.

3. National Competition—The National Competition Committee shall be responsible for the National Competition, including the handling of publicity, information, timing arrangements with the Papers Committee, appointment of judges and session chairmen.

Classifications

There shall be two classifications for entries in the competition.

(a) Class I—Residential Lighting. Entries may be for interior and/or exterior applications of residential lighting.

(b) Class II—Commercial Lighting. Entries may be for commercial, industrial or any other lighting application as shown in the *IES Lighting Handbook*, Third Edition, in Sections 10 to 24 inclusive (other than Section 15).

The final decision as to which category an entry may compete in, shall be that of the competition chairman, Local, Regional or National.

No contestant may present more than one entry in any one class.

Eligibility—Entry Information

1. Any Associate, full Member, or Fellow of the Society, or member of a Residence Lighting Forum affiliated with the Society, is eligible to enter the competition, excluding National Officers, members of Council, and employees of the Society.

2. An entry may be by an individual or by a team.

3. Only a lighting installation completed during the 18 months preceding the local competition is eligible for entry in the competition.

4. No member may submit an entry concerning a lighting installation, or any part thereof, which has been entered previously in another contest not affiliated with or conducted by the Society.

5. If an entry describes a lighting installation or application located outside the area covered by the Section or Chapter to which the member is affiliated, then only the originator of the lighting design is eligible. It shall not be considered valid for two members to present the same entry in more than one such area.

6. All entries must be made on the official entry form provided by the Society, and shall allow, free, the first right of publication to ILLUMINATING ENGINEERING, the official publication of the Society.

7. Entries proposed for the Section or Chapter competition shall be approved by the competition chairman before completion, to ensure acceptance for presentation. If more entries are submitted than can be presented within the normal time of a meeting, the chairman may request summaries to be submitted so the Board of Judges may rule on their acceptance. All summaries shall be received not less than 30 days prior to the competition meeting.

8. Absolutely no mention, nor identifiable illustration of a specific lighting product name may appear on any part of the presentation.

9. Presentation by each contestant shall be limited to ten minutes, and contestants shall be notified that this rule is strictly enforced, with a judging penalty for overtime.

Judging

1. The Board of Judges shall consist of three members of the Society in any grade other than student or associate, for each class. [Care should be taken to select qualified, impartial judges. Due to the heavy conference work schedule, National Officers should be avoided, although Members of Council or qualified conference speakers may be appointed. For Regional Conferences, it is preferable to select members from other Regions.]

2. Appointment of judges shall be as follows:

(a) For Section and Chapter competition—by the local Board of Managers.

(b) For Regional Conference competition—by the Regional Vice-President.

(c) For National Technical Conference competition—by the Chairman of the National Competition Committee.

3. The competition chairman at each competition, Local, Regional or National, will meet with the judges prior to the competition, acquainting them with the rules and judging procedure. Judges will be supplied with score sheets and the entry of each contestant will be available prior to the presentations.

4. The basis upon which an entry in either classification shall be judged will be:

(a) *The Problem*—the extent of difficulty which the lighting problem presented to the contestant.

(b) *The Solution*—ingenuity which the contestant exercised in solving the installation problem.

(c) *Usefulness of the Solution*—Entry's usefulness to the user and value to Society members as an example of good current lighting practice.

(d) *Presentation*—The organization of the presentation. Note: Contestants will not be judged on the oral delivery of their presentation.

5. The three judges in each class will deliberate as a group and may appoint one of their number to be chairman. They may also appoint an additional person to act as secretary. The secretary shall have no vote in the selection of a winner.

The secretary may perform any or all of the following duties, as assigned by the judges or competition chairman.

(a) Check the eligibility of all contestants.
(b) Distribute score sheets.
(c) Make entry forms available to judges.
(d) Act as Timer.
(e) Escort judges to anteroom for their deliberations.
(f) Tabulate judges' votes.
(g) Destroy all score sheets after selection of winners.
(h) Compile written list of winners and deliver to competition chairman as soon as possible.
(i) Make arrangements for the judges to be seated separately, preferably at tables at the front of the room so they will be sure to see and hear well.
(j) Arrange for title of each presentation, class, and name of contestant on each score sheet supplied to the judges.

Awards

Cash prizes, merit award certificates, and trophies shall be awarded to the winning entries in each class as follows:

(a) Section and Chapter Competitions

First Prize—$15 and award certificate
Second Prize—$10 and award certificate

Funds for prizes to be requested from IES Headquarters by appropriate Section and Chapter officers.

(b) Regional Conference Competitions

First Prize —$25 and award certificate
Second Prize—$15 and award certificate
Third Prize —$10 and award certificate

Funds for prizes to be provided from budget of the Regional Conference. At the option of the Regional Conference Committee, first prize may be increased to $75.

(c) National Technical Conference Competition

First Prize —$100 and award certificate
Second Prize—$50 and award certificate
Third Prize —$25 and award certificate
Fourth Prize—$15 and award certificate

The President Goddard Trophy (silver cup) shall be presented jointly to winners in both classes, and their names shall be inscribed on the trophy. Silver miniatures of the trophy will be presented to winning contestants in each class, for permanent possession. The national prizes will be presented by the President of the Society at the President's Banquet.

Competition Procedure

1. For uniformity, it is recommended that all Sections and Chapters schedule their competitions during January, February or March.

2. The competition should be announced early in the fiscal year, so that all entries may be approved or summaries received not less than 30 days prior to the competition meeting date.

3. If presentations at a local meeting are considered impracticable, the Board of Judges shall review the summaries at least 30 days prior to the Regional Conference. The entry judged best in each class shall be announced and the authors invited to complete the entry for presentation at the Regional Conference Competition.

4. In the Region in which no Regional Conference is held (because National Technical Conference is held in that Region), then the competition shall be held immediately prior to the National Technical Conference. Prize money for this competition shall be supplied from National funds.

5. If a contestant cannot attend a competition (Local, Regional or National), he may select a proxy or proxies to present his entry. For the Local Competition, proxy shall be member or members of contestant's Section or Chapter. For the Regional and National Competitions, proxy shall be member or members of contestant's Region. A proxy must qualify under Rule No. 1 of "Eligibility."

6. Contestants in the National Competition are urged to make their presentations themselves or by proxy. If this is not possible, however, an entry may be submitted for presentation on tape-recording, on application to the Chairman of the National Competition Committee.

7. At a convenient time prior to the Contest Session, the Competition Chairman shall instruct the contestants on procedure and timing, and will conduct a draw for the order in which presentations will be made.

8. The Competition Chairman will coordinate with the Publicity Chairman of the National Technical Conference to ensure the maximum press coverage for the competition and the winners. He should arrange to have a photographer available to take pictures of the winners. Full information should be sent immediately to the Editor of the Society's publication, ILLUMINATING ENGINEERING.

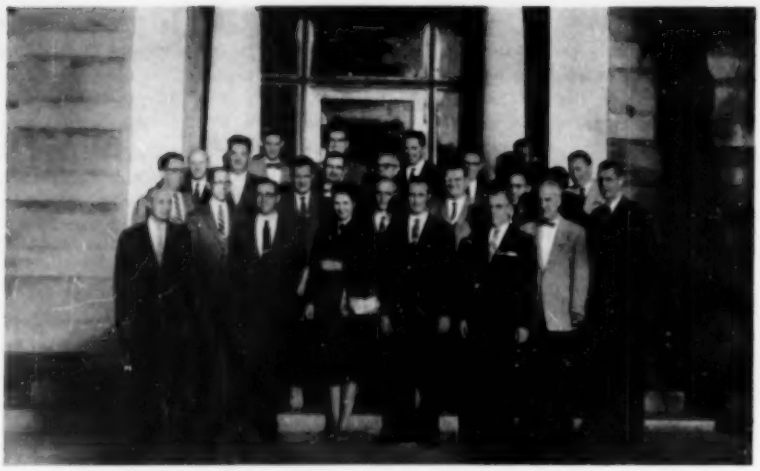
9. Each Section and Chapter Competition Chairman (and/or Section or Chapter Chairman) shall submit to his Regional Vice-President, not less than 30 days prior to the Regional Conference: (a) Name and business affiliation of the winning contestant in each class, and (b) title of the winning entry.

10. Each Regional Vice-President shall submit to the National Competition Chairman, immediately following the Regional Conference: (a) Name and business affiliation of the winning contestant in each class, and (b) title of the winning entry.

Send for Your Entry Form Now

Entry forms for the IES Applied Lighting Competition are available at IES Headquarters. Send request to John K. Michel, Membership Secretary, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Here and There at IES Opening Meetings



Tour through the American Optical Co.'s plant in Southbridge, Mass., was the New England Section's first technical program for 1959-1960. Following the two-hour tour, the group listened to a lecture on "Fiber Optics" by Dr. MacNeille, head of research at American Optical Co.

Panel discussion on the Blackwell Report opened the year for Rocky Mountain Section. The panel, from left to right: Gordon A. McDonald, moderator; Dr. Donald H. O'Rourke, eye surgeon; Maurice Dodd, consulting electrical engineer; Edward S. Goldman, Central Electric Co., and Ormal Mrsney, Swanson-Rink & Associates. Sixty members and guests enjoyed the stimulating program arranged by Gregg Cloos, the Section's Program Chairman.

With South Pacific Coast RVP James E. Barnes (center in photo at left) handing the gavel to incoming Chairman Benn Hartmann (left), Southern California Section began the 1959-1960 IES year. Frank Lee, outgoing Chairman, is pleased onlooker. Featured at the meeting were reports by Foster K. Sampson on the CIE meeting in Brussels in

June and Roy Kreyser's synopsis of the goings-on at the National Technical Conference in San Francisco. At the Section's Study Club meeting (photo at right) Nick Ivanicki (left), Sunbeam Lighting Co., and Jerry Silvers, Study Club Chairman, discussed and demonstrated measurement, recording and significance of fixture brightness.

LIGHTING NEWS

US National Committee Elects New Officers
Willard C. Brown Named as President

Members of the United States National Committee of Commission Internationale de l'Eclairage (International Commission on Illumination) met at State College, Pa., October 12 and 13, to elect new officers and Executive Subcommitee. This group will guide American participation in international lighting for the next four years. Assignments were also made at the State College meeting, of personnel to technical committees, working toward the next international conference of CIE, scheduled for 1963 in Vienna.

W. C. Brown, manager of lighting education at General Electric Co., Nela Park, was elected President of the USNC. He succeeds H. Herbert Magdsick, of Cleveland, Ohio, who has served as USNC President since 1955. Mr. Brown is a Fellow of IES and a Past-President (1941-1942), and is internationally known for his work in illuminating engineering.

Professor Everett M. Strong, Cornell University, Ithaca, N. Y., also a Fellow and Past-President of IES (1952-1953), will serve as Vice President of the Committee during the next quadrennium.

T. D. Wakefield, Wakefield Lighting, Inc., Vermilion, Ohio, has been elected Secretary for the coming four years. Previously, he served the United States Committee as Treasurer.

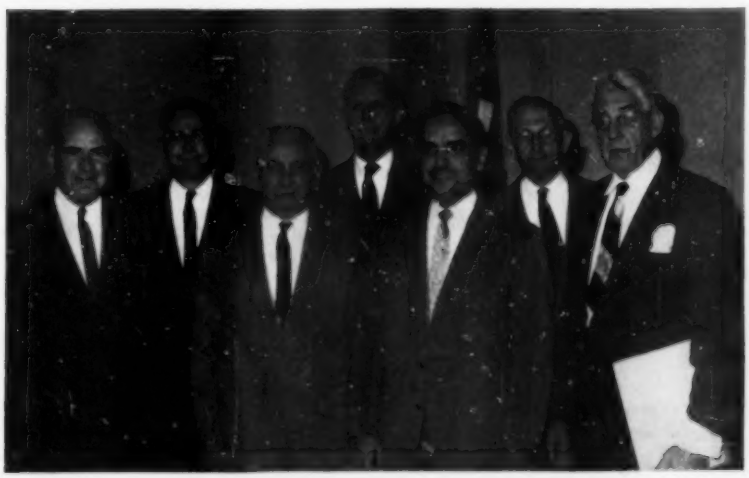
L. E. Barbrow, National Bureau of Standards, Washington, D. C., long active in the executive body of the USNC, will serve as Treasurer. Mr. Barbrow is also a Fellow of IES.

Three members were elected to the Executive Subcommittee, all of them Fellows of IES. Serving in this capacity will be: **S. G. Hibben,** Montclair, New Jersey; **Professor Russell C. Putnam,** of Case Institute of Technology, Cleveland, Ohio; and **Arthur A. Brainerd,** Philadelphia, a past president of USNC, and long an officer of the Committee.

Purpose of the International Commission on Illumination is to develop international standards dealing with the measurement of light, colorimetry, sources of radiation and application standards for street lighting, automobile headlights, traffic control, marine lighting, aviation lighting, and in fact, all phases of light and vision.

Participation in this international group is, of course, of great benefit to lighting interests all over the world. Some 32 countries are members, including the US. The American activity within this international organization is a prime interest of some 200 or more top people in the lighting industry in this country. Participation by many more is a standing invitation of the US group.

Further business conducted by the USNC at its October meeting included action on a number of recommendations of the American delegation which represented the United States at the CIE Congress held in Brussels last June. (For a report on this refer to August 1959 issue of ILLUMINATING ENGINEERING, pages 8A to 12A.)



GUIDING American participation in the Commission Internationale de l'Eclairage for the next four years are newly-elected United States National Committee officers, l. to r.: R. C. Putnam; T. D. Wakefield, Secretary; E. M. Strong, Vice President; Willard C. Brown, President; L. E. Barbrow, Treasurer; A. A. Brainerd and Samuel G. Hibben.

Dr. J. W. T. Walsh Awarded First British IES Gold Medal

At the October 13 meeting of the British IES in London, Dr. John W. T. Walsh, O.B.E., was named the first Gold Medallist of the British Illuminating Engineering Society.

Dr. Walsh, an internationally known and respected figure in the field of illumination, spent his active professional career at the Photometry Department of the National Physical Laboratory, from which he retired in 1951, after 38 years of association. His first outstanding contribution to the lighting field was a large-scale photometric survey of factory lighting, made for the Home Office Departmental Committee in 1913. During his years at the Laboratory he supervised much important work relating to the principles of good lighting and the design

FIRST British IES Gold Medal presented to Dr. J. W. T. Walsh, left, by C. C. Smith, IES President. The Medal, awarded for outstanding contributions to lighting, was struck to commemorate the Society's Golden Jubilee.

and performance of lighting equipment.

Dr. Walsh's publications include papers on all aspects of photometry and lighting, the most outstanding being his 1926 treatise on photometry, which is accepted as the standard work on this subject. A revision of that book appeared in 1953. At the request of the British IES, Dr. Walsh authored *A Textbook of Illuminating Engineering*. He also collaborated in making available the English translation of Professor Yves LeGrand's treatise on physiological opites.

A member of the British IES since 1923, Dr. Walsh has the distinction of being the Society's only member to serve two terms as president (1929 and 1947).

In the field of international lighting, his contributions have also been notable. For many years he served as Chairman of the British National Committee of CIE, participating actively in the work of the international organization. He was vice president and honorary secretary of Commission Internationale de l'Eclairage and is its most recent past president, having held that office from 1955-1959.

The British IES Gold Medal, established on the occasion of the Society's Golden Jubilee, will be awarded at intervals of not less than two years for outstanding contributions to the advancement of lighting. The design of the Medal features Apollo riding across the path of the sun. (According to ancient mythology, Apollo was entrusted by Jupiter with the task of spreading light over the world.) The reverse side of the Medal bears laurel leaves and the inscription "For Outstanding Contributions to the Advancement of Lighting—Dr. J. W. T. Walsh, O.B.E., 1959."

Electrical Code School Offered in New Orleans

The New Orleans Chapters of the National Electrical Contractors Association and the Association of Independent Electrical Contractors, in cooperation with the Department of Safety and Permits of the City of New Orleans, recently sponsored a course for study and review of the newly revised National Electrical Code.

The course was under the direction of Ben Segall and consisted of ten two-hour sessions, held in the New Orleans City Hall. Fee for the course was $15.

The 1959 National Electrical Code is a complete editorial revision of earlier codes incorporating many basic changes in Code rules.

Historical Committee Luncheon For Dr. John N. Aldington

The Historical Committee of IES was host, on October 26, at a "friendship" luncheon in honor of Dr. John N. Aldington of Great Britain, held at the Engineers Club in New York City. The luncheon was given during Dr. Aldington's recent visit to this country in connection with his new position as director of the Associated Electrical Industries, Ltd., of Great Britain.

Dr. Aldington is well-known for his research and development work at the laboratories of the Siemens Co. of Preston, Lancashire, especially for studies of high-pressure metallic vapor illuminants in quartz and the production of white light from xenon gas. Many of his pioneering achievements have been reported in papers presented before the American IES, of which he is a member.

H. L. Logan, Historical Committee Chairman, officiated at the luncheon, which numbered among its guests: Past Presidents of IES, W. F. Little, M. N. Waterman, S. G. Hibben and J. W. Barker; New York Section Chairman W. H. Keen; Managing Director A. D. Hinckley; Technical Director C. L. Crouch; C. C. Keller, Holophane Co., Inc.; H. E. Mitchell, Westinghouse International; F. F. Garych, General Electric International and Gregory Rice, Sylvania International.

E. H. Herzberg Receives McGraw Contractors Award

The 1959 Contractors Medal and purse of the James H. McGraw Award for Electrical Men was awarded to Edwin H. Herzberg for leadership in the development and building of the industry's apprenticeship and training program. Presentation of the award was made during ceremonies at the National Electrical Contractors Association General Meeting on November 9, Fountainebleau Hotel, Miami Beach, Fla.

Mr. Herzberg, manager of the Milwaukee Chapter of the NECA, conceived the idea of sponsorship of apprenticeship and continuous training of journeymen electricians as the joint responsibility of the contractor and union. He established a model joint apprenticeship program in Milwaukee and in 1940 served as chairman of the Apprenticeship Committee of NECA. With the establishment of the National Joint Apprenticeship and Training Committee for the Electrical Industry in 1941, Mr. Herzberg was named chairman, a position he held for almost 12 years.

The James H. McGraw awards are made in four fields of the electrical industry—contracting, distribution, manufacturing and cooperation within the industry. Each prize consists of a bronze medal and a one hundred-dollar purse.

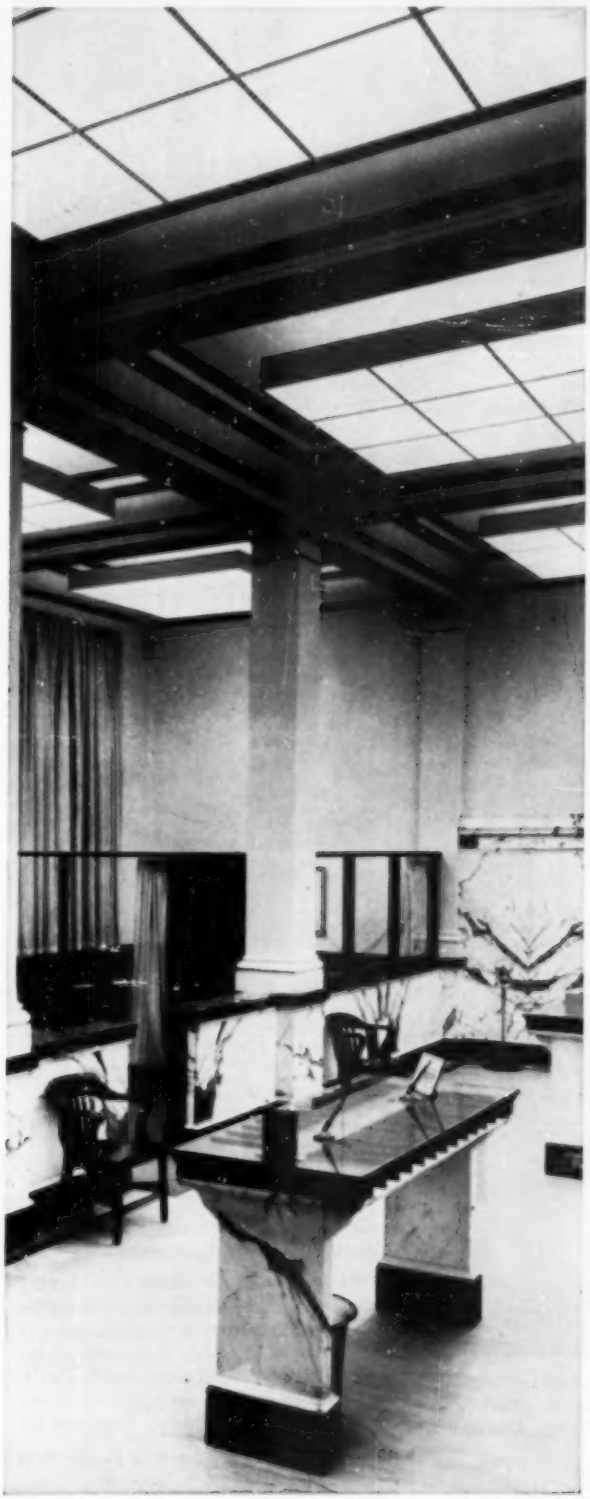
Consulting Engineers Group Organized in Massachusetts

Principals of 19 metropolitan Boston electrical, civil, mechanical and structural consulting engineering firms met in Boston on October 17 to organize the Massachusetts Association of Consulting Engineers, with the basic purpose of advancing the value of the consulting engineer to the public.

Temporary officers elected are: Chairman, H. P. Duffill, Duffill Associates; Vice-Chairman, Paul Norton, Nichols,

(Continued on page 12A)

LPI Panelaire modernizes bank's lighting, large-area units give comfortable, high-level illumination



Panelaire luminaires provide 110 footcandles maintained illumination in the Bank of Belmont, Belmont, N. C. Modular units adapt easily to existing ceiling bays. This modernization features eleven 6' x 6' Panelaire units and three 6' x 8' units, suspended on 18-inch stems. Each unit has six 800 ma Rapid Start lamps. GENERAL CONTRACTOR — *Hand Construction Co.;* ELECTRICAL CONTRACTOR — *Belmont Electric Co.;* DISTRIBUTOR — *Electrical Distributors of Charlotte;* CONSULTING ENGINEER—*Frank Wooten and Associates.*

Now proved in hundreds of applications

The Panelaire "floating panel" luminaire was developed and first introduced by Lighting Products Inc. Since introduction, its use in hundreds of applications has proved it to be a simple, practical and efficient means of providing high-level lighting.

Fits any shape area

Panelaire's wide acceptance is due in part to its modular construction that permits unlimited freedom in architectural design. Luminaires in nine different sizes, from 2' x 4' to 6' x 8', may be ganged together, easily making areas, islands or lines of light. Floating ceilings that clear the walls eliminate costly fitting and installation. Panelaire 2-, 4-, or 6-lamp units come fully pre-assembled in individual cartons, ready to install.

High-level illumination

Panelaire provides illumination levels up to 300 footcandles. It uses Slimline lamps, high output Rapid Start lamps, or Power Groove lamps to provide high level, glare-free light for large-area applications. Panelaire is UL-listed and is available with a variety of diffusers to suit your application.

Mail coupon for complete information, technical and photometric data

LPI FLUORESCENT LIGHTING

Lighting Products Inc., Highland Park, Illinois

Please send latest Panelaire bulletin. IE

Name

Firm

Address

City *Zone* *State*

AUDIENCE of some 500 people heard Past President G. J. Taylor's lecture on "New Trends in Illumination" at North Texas Section's lighting exposition.

(Continued from page 10A)

Norton and Zaldastani; Treasurer, C. D. Bratiotis, Hayden, Hardin & Buchanan and Secretary, J. F. Maguire, Jr., Stressenger, Adams, Maguire & Reidy. Mr. Duffill was authorized to represent the group at the semi-annual board of directors meeting of the Consulting Engineers Council in Cincinnati, November 6-8, as an observer.

Membership in the organization will be limited to Registered Engineers in Massachusetts who are principals of firms principally engaged in the independent practice of professional consulting engineering. Further information on membership may be obtained from Francis J. Linehan, Jr., 6 Beacon St., Boston 8, Mass.

North Texas Section Sponsors Lighting Exposition

An important industry service was undertaken by the North Texas Section (Dallas) November 6, with smashing success. This was their Second Annual Lighting Exposition, staged at the Will Rogers Memorial Auditorium in Dallas, extending throughout the day, from 10 a.m. to 10 p.m.

Recent developments in commercial, industrial, office and school lighting equipment were exhibited in booths manned by factory representatives and engineers prepared to discuss in detail current recommendations and lighting design. Some 500 southwestern architects, engineers and lighting personnel attended the exposition, by invitation of the Section. Earl I. Dinsmore of the North Texas Section was the local chairman who directed the successful program.

An additional valuable feature of the exposition was an evening lecture session, with George J. Taylor, past president of IES, as principal speaker. Mr. Taylor discussed, before the audience of 500 visitors, "New Trends in Illumination."

Participants in the exposition included:

Advance Transformer Co.
Century Lighting, Inc.
Curtis-Allbrite Lighting, Inc.
Day-Brite Lighting, Inc.
Edwin F. Guth Co.
Electro Lighting Corp.
Garcy Lighting, Inc.
General Electric Lamp Division
Globe Illumination Co.
Hexcel Products, Inc.
Holophane Co., Inc.
Keystone Electric Manufacturing Co.
Lam, Inc.
Lighting Dynamics, Inc.
Lightolier, Inc.
McPhilben Lighting Co.
The Miller Co.
Miroflector Co.
Naturalite, Inc.
N-L Corp.
Philadelphia Electric & Manufacturing Co.
Prescolite Manufacturing Corp.
Revere Electric Manufacturing Co.
Shalda Manufacturing Co., Inc.
Smithcraft Lighting, Inc.
Stanley Electric Manufacturing Co.
Sunbeam Lighting Co.
The Superior Electric Co.
Sylvania Lamp Division
Westinghouse Electric Corp.
Wide-Lite Corp.

GUIDING FORCE behind North Texas Section's successful lighting exposition l. to r.: Section Chairman A. Paul Crick and Exposition Chairman Earl I. Dinsmore shown here with IES Past President G. J. Taylor, Managing Director Dex Hinckley and Southwestern RVP John B. Deck, Jr.

Case Conference Studies Future Teacher Sources

Development of young engineering faculties and increasing the effectiveness of young engineering teachers was the subject of a three-day conference of the Committee on Development of Engineering Faculties of the American Society for Engineering Education on November 19-

(Continued on page 15A)

For Low Cost "Controlled" Small Area Floodlights Specify... *new*

APPLETON®

"3020 Series" Mercury Vapor Reflector Lamp Floodlights

The APPLETON "3020 Series" floodlight is particularly suitable for low cost floodlighting of gasoline service stations, parking lots, outside storage areas and other open locations because it is designed to fully utilize light normally escaping other types of floodlights.

Uses 400 Watt R 52 hard glass color improved and white mercury vapor reflector lamps. Is fully adjustable for both horizontal and vertical aiming. Hood and reflector both are weather resistant with three styles of mounting hoods for easy installation.

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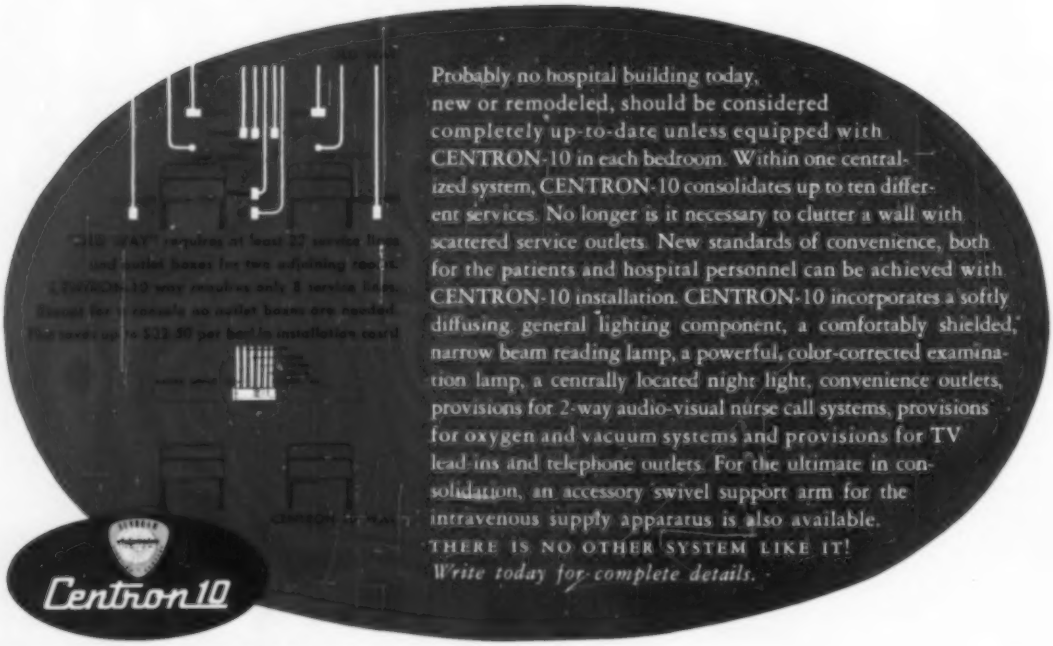

Probably no hospital building today, new or remodeled, should be considered completely up-to-date unless equipped with CENTRON-10 in each bedroom. Within one centralized system, CENTRON-10 consolidates up to ten different services. No longer is it necessary to clutter a wall with scattered service outlets. New standards of convenience, both for the patients and hospital personnel can be achieved with CENTRON-10 installation. CENTRON-10 incorporates a softly diffusing general lighting component, a comfortably shielded, narrow beam reading lamp, a powerful, color-corrected examination lamp, a centrally located night light, convenience outlets, provisions for 2-way audio-visual nurse call systems, provisions for oxygen and vacuum systems and provisions for TV lead-ins and telephone outlets. For the ultimate in consolidation, an accessory swivel support arm for the intravenous supply apparatus is also available.

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(*Continued from page* 12A)

21. Case Institute of Technology, Cleveland, was host to the Conference, which was supported by the Ford Foundation. Dr. Ray E. Bolz, head of the Department of Mechanical Engineering and Engineering Science at Case, was chairman of the conference.

Representing what may be the first such gathering of its kind, a distinguished group of engineering educators met with outstanding educators from the fields of psychology, sociology and higher education for critical discussion of the problems involved in the effectiveness of young teachers.

A sympathetic understanding of students, ability to communicate in a clear, concise manner, knowledge of the psychological process of learning, skill in helping students set objectives are important assets in a teacher. The study of these psychological factors was the theme of the conference.

Studies on the vast expansion in high-school enrollments show that the engineering student body will double within the next decade, requiring 1000 new teachers of engineering per year. These teachers must be recruited from the nation's graduate schools and a large proportion of them will be inexperienced in the teaching field.

The Committee on Development of Engineering Faculties, a three-year-old activity of the ASEE, is concerned with the study of recruitment, development and utilization of engineering college faculties, in a program of improvement.

Analysis of '59 Electrical Code — New Rules in Step with Wiring Drive

An analysis of the 1959 edition of the National Electrical Code shows that the compilers of the recognized recommendations for electrical safety are in step with the electrical industry's campaign for full housepower—homes wired to provide top electrical service for all available appliances.

"Analysis of 1959 Revision of National Electrical Code," a 107-page review of Code changes, was compiled by Howard Michener, assistant manager of the NEMA Engineering and Safety Regulations Department. The review was released last month in connection with NEMA's 33rd Annual Meeting in Atlantic City, N. J.

Several new important electrical safety requirements are contained in the 1959 Code, which differs completely, in format, from the previous (1956) edition. One major revision requires that the following appliances and hand-held, motor-operated tools be grounded: clothes washers, dish-

(*Continued on page* 16A)

SCHEDULED EVENTS

January 5, 1960—Council Executive Committee Meeting, Illuminating Engineering Society, New York, N. Y.

January 12-15, 1960—The Society of Plastics Engineers, Inc., 16th Annual Technical Conference, The Conrad Hilton Hotel, Chicago, Ill.

January 25-28, 1960—Plant Maintenance Show, Convention Hall, Philadelphia, Pa.

January 31-February 5, 1960—American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

February 11, 1960—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

February 22-25, 1960—National Rural Electric Cooperative Association (Annual Meeting), St. Louis, Mo.

February 25-26, 1960—Annual National Wiring Sales Conference, Warwick Hotel, Philadelphia, Pa.

March 6-9, 1960—Fifth Electrical Industries Show, New York City Coliseum, New York, N. Y.

March 10, 1960—Council Executive Committee Meeting, Illuminating Engineering Society, New York, N. Y.

March 23-26, 1960—Tenth Electrical Industry Show and Lighting Exposition, Shrine Exposition Hall, Los Angeles, Calif.

April 5-7, 1960—Building Research Institute, Spring Conferences, Statler-Hilton Hotel, New York, N. Y.

April 11-12, 1960—Inter-Society Color Council, Philadelphia Museum College of Art, Philadelphia, Pa.

April 20, 1960—Council Executive Committee Meeting, Illuminating Engineering Society, Memphis, Tenn.

April 21-22, 1960— South Central—Southeastern Regional Conference, IES, Hotel Peabody, Memphis, Tenn.

April 25-26, 1960—Southwestern Regional Conference, IES, Robert Driscoll Hotel, Corpus Christi, Texas.

April 28-29, 1960—Inter-Mountain Regional Conference, IES, Hotel Westward Ho, Phoenix, Ariz.

May 1-5, 1960—National Association of Electrical Distributors, Dallas, Texas.

May 4-5, 1960—South Pacific Coast Regional Conference, IES, Ambassador Hotel, Los Angeles, Calif.

May 9-10, 1960—Pacific Northwest Regional Conference, IES, Benjamin Franklin Hotel, Seattle, Wash.

May 10-12, 1960—American Institute of Electrical Engineers (Farm Electrification Conference), Sheraton-Fontenell Hotel, Omaha, Nebr.

May 12-13, 1960—Midwestern Regional Conference, IES, Sheraton Martin Hotel, Sioux City, Ia.

May 16-17, 1960—Great Lakes Regional Conference, IES, Hotel Carter, Cleveland, Ohio.

May 23-26, 1960—Design Engineering Show, Coliseum, New York, N. Y.

June 8-9, 1960—Northeastern Regional Conference, IES, Wentworth-by-the-Sea, Portsmouth, N. H.

June 13-14, 1960—Canadian Regional Conference, IES, Nova Scotian Hotel, Halifax, N. S.

June 16, 1960—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

August 8-12, 1960—American Institute of Electrical Engineers, Pacific General Meeting, San Diego, Calif.

September 6-16, 1960—Production Engineering Show, Navy Pier, Chicago, Ill.

September 11-16, 1960—Illuminating Engineering Society, National Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

September 28-30, 1960—Canadian Electrical Manufacturers Association, Sheraton-Brock Hotel, Ningara Falls, Ont.

October 9-14, 1960—American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

October 23-27, 1960—National Electrical Contractors Association, Las Vegas, Nevada.

November 14-18, 1960—National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

I.E.S. National Technical Conferences

1960 — September 11-16 — Penn Sheraton Hotel, Pittsburgh, Pennsylvania

1961 — September 24-29 — Chase Park Plaza Hotel, St. Louis, Missouri

1962 — September 9-14 — Statler-Hilton Hotel, Dallas, Texas

1963 — September 8-13 — Sheraton-Cadillac Hotel, Detroit, Michigan

(Continued from page 15A)

washers, hedge clippers, lawn mowers, sanders, saws, wet scrubbers and automatic drills with a chuck capacity of over ¼ inch. Grounding is accomplished by connecting the tools and appliances to grounding-type receptacles.

Another major Code revision allows more than nine conductors in a single metal raceway, such as conduit. This new ruling provides freedom for running several circuits through a single raceway. This rule has great importance in the wiring of apartment houses.

Requirements for location of grounding type outlets have been expanded to include laundry rooms, basements and exterior walls where plug-in equipment may be used by people standing on cement or other conductive surfaces.

"Single-family residences with an electrical load of 10 kilowatts or more must have a minimum service of 3-wire, 100-ampere capacity," according to the Code. Wall ovens and counter-top cooking units, both treated as "fixed" appliances, must be served by individual 20-ampere branch circuits.

As in previous editions, the Code states that one receptacle outlet should be installed for every 12 linear feet of usable wall space, measured horizontally, around each room.

Copies of Mr. Michener's analysis of the 1959 Code are available from NEMA Headquarters, 155 East 44th St., New York 17, at 50 cents per copy.

Luncheon in Honor of North Texas Sustaining Members

Past-President George J. Taylor, in his new IES capacity of National Sustaining Membership Chairman, was principal speaker November 5 at a luncheon meeting for local Sustaining Members of IES, at the Dallas Athletic Club. Managing Director, A. D. Hinckley, also spoke briefly about some phases of the Society program. Prior to the luncheon, Mr. Taylor greeted top executives of the Texas Power & Light Co.—Bassett Watson, Vice President in Charge of Sales; C. W. Wooldridge, Director of Public Service and W. W. Lynch, President. Those representing the Sustaining Members and North Texas Section present at the luncheon were:

From the Dallas Power & Light Co.—P. M. Rutherford, vice president in charge of sales and W. Everett Folsom, commercial sales manager. Both are past Regional Vice Presidents of the Society and Mr. Rutherford is Chairman of the Executive Committee for the 1962 National Technical Conference in Dallas.

(Continued on page 18A)

Regional Organizational Meetings—1959

AT THE START of each IES year, regional organization meetings are one of the first orders of business. Section and Chapter officers meet with the Regional Vice President (and other Society officers, where possible) to discuss plans and problems for the coming year. Managing Director A. D. Hinckley brings valuable assistance from Headquarters. Two of the first such meetings of the 1959-1960 year are pictured below.

CANADIAN Regional Activities Committee meeting, held recently in Montreal, was attended by officers from all Sections and Chapters in the Region and several IES notables. L. to r. around the table: J. Carl Wilson, Past RVP; J. G. Ferraris, Bluenose; G. Franklin Dean, IES General Secrtary; R. P. Lindsay, Toronto; Gerry Dunnigan, Quebec; Ed Wilcox, Maritime; Wally Moore and John Shepherd, Montreal; Joe Thomas, IES Director; Jacques Beaudet, Montreal; A. D. Miller, Ottawa; A. D. Hinckley, Managing Director; H. Talbot, Shawinigan Water & Power Co. (hosts to the meeting); John M. Chorlton, Regional V-P; Gerry Labrosse and Dionis Hebert, St. Maurice Valley.

SOUTHWESTERN Regional Vice President John B. Deck, Jr. (standing at head of table) presides over Southwestern Regional organizational meeting in Dallas. Managing Director A. D. Hinckley is at Mr. Deck's left; Past President George J. Taylor at right.

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are now **MORE IMPORTANT** than ever!

YES! The new, much higher Industrial Lighting levels now recommended by I.E.S.* make QUALITY more important than ever!

Q *Why is reliance on fixtures with the RLM LABEL more important than ever?*

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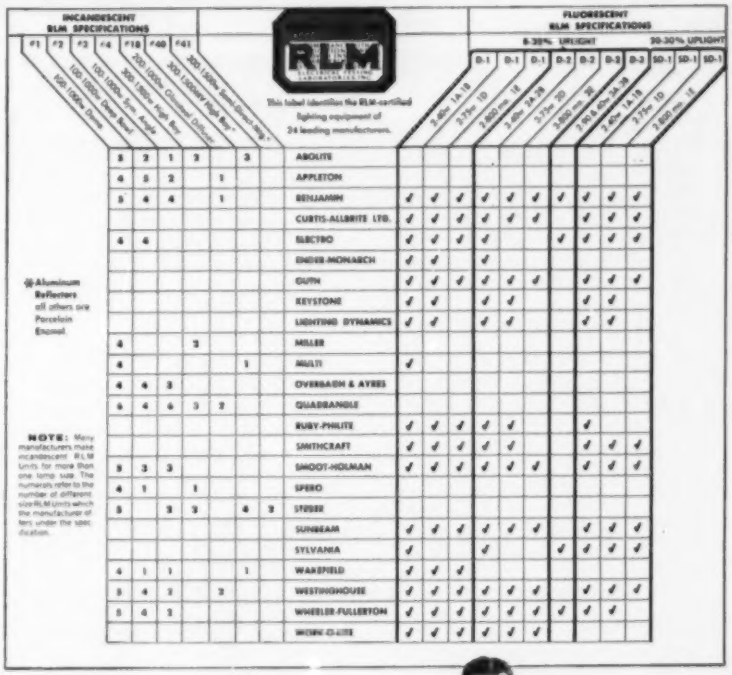
A *By mailing the COUPON TODAY.*

Be sure to check all items on which you desire information.

**The Illuminating Engineering Society is a non-profit organization of illuminating engineers and others interested in the advancement of the science of illumination.*



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RLM STANDARDS INSTITUTE

(Continued from page 16A)

From Texas Electric Service — O. O. Carlson, general sales manager.

From Texas Power & Light Co. — D. S. Coffman, manager of industrial sales; E. H. Gardiner, Jr., manager of residential and commercial sales; and lighting engineers Charles J. Lee, Harold D. Samuels, and John B. Deck, Jr., Regional Vice-President of the Southwestern Region of IES.

During the North Texas Lighting Exposition on November 6th, representatives of the Sections and Chapters in the Southwestern Region gathered for the regional organization and nominating meeting. Regional Vice-President, John B. Deck, Jr. presided during this all-afternoon meeting which was also attended by Mr. Taylor and Mr. Hinckley.

New York Architects Fly to Office Lighting Seminar

A group of 48 leading New York architects, engineers and interior designers recently made a one-day flying trip to the General Electric Lighting Institute in Nela Park, Cleveland, for a practical demonstration of modern office lighting practices. The trip was arranged by C. Wesley Meytrott, sales vice president of Consolidated Edison Co. of New York, after learning that lighting specifications in many of New York's new office buildings now under construction or in the planning stage are considerably below the levels recommended by IES.

The full-day education program included a review of the history of lighting standards, the practical nature of the new IES recommendations, cost of office lighting in relation to other construction, maintenance and labor costs, integration of lighting, heating and air conditioning and the increasing importance of lighting as an element of architectural design.

The visiting group included representatives of government authorities and the New York City Board of Education, as well as representatives of commercial companies.

Reorganization Plans Approved by NEMA

Reorganization plans to "merge the efficiencies of corporate management with its [NEMA's] present top-flight trade association practices" were approved by the membership of the National Electrical Manufacturers Association during the organization's convention in Atlantic City, N. J. last month. The new scheme, presented by W. C. Wichman, a Vice President of General Electric Co. and Chairman of the NEMA Planning Committee, calls for the formation of eight semi-autonomous Divisions, a broadening of the Association's product scope pattern and the expansion of its present membership base.

The eight new Divisions will be comprised of industry product Sections having mutual interests, who will be guided by their own Boards of Directors and represented in NEMA policy matters by their respective elected Divisional Vice Presidents. The Divisions will be made up of Sections whose member companies produce consumer products, lighting equipment, industrial equipment, building equipment, insulating materials, wire and cable, generation, transmission and distribution equipment and industrial electronics and communications equipment.

With the broadening of the product scope, the newly created Divisions will be able to go beyond designated products within their constituent Sections and include in their membership several important phases of the electrical industry which are, at the present time, outside of NEMA's restricted province.

The tremendous growth of the electrical industry, including the rise of the $9 billion appliance industry, in the 33 years since the formation of NEMA necessitated the reorganization of the Association to meet the present-day needs of the industry.

The new Lighting Equipment Division will include Sections for aviation ground lighting, floodlighting, industrial and commercial lighting equipment and street lighting.

FLYING one-day course in modern office lighting was sponsored by Consolidated Edison Co. of New York, for these 48 New York architects and engineers, shown here after their landing in Cleveland for a full-day program of lectures and demonstrations.

Electric Power Production US vs. USSR Studied

Soviet Russia's production of electricity, an indicator of total national industrial productive capacity, will lag considerably behind that of the United States for the foreseeable future, according to a report presented before the Subcommittee on Economic Statistics of the Joint House-Senate Economic Committee. Edwin Vennard, Vice President and Managing Director of the Edison Electric Institute prepared the study, which was presented at the Subcommittee's November hearings on comparison of United States and Soviet economic growth.

Mr. Vennard's paper was based on information gathered during a two-part inspection tour of Soviet electrical facilities, recently completed by a team of American electric power experts.

At the end of 1958, Russian power capacity was 53,100,000 kilowatts; United States capacity, 160,219,000 kilowatts. Russia's goal for 1965 is 108,000,000 kilowatts; the United States should produce 245,000,000 kilowatts in that year.

Approximately eighty-one per cent of power production in both countries is generated by steam; 19 per cent by hydroelectric plants. Because steam plants are cheaper and easier to build, the Soviet Union plans to increase the proportion of steam generation of electric power to 85 per cent by 1965.

Atomic power programs in both the US and USSR are still in the research

(Continued on page 21A)

High Intensity Luminaire for Entryways, Walkways and Loading Areas

The PERFECLITE

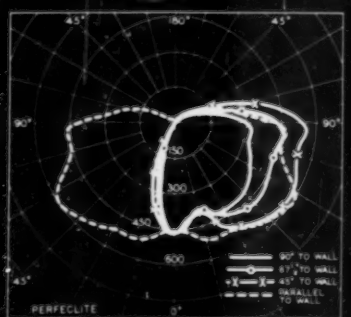
"PHAROS"

A Totally New Concept In Controlled Exterior Illumination

Another first from Perfeclite! A modular shaped lighting fixture that completely outmodes the usual exterior bracket extending on a heavy arm from the wall.

Ultra-modern in design, the new Pharos gives an asymmetric light pattern . . . provides high intensity illumination for wall areas . . . disperses a powerful outward distribution of light 90° from the wall as well. The heat-resistant glass refractor uses accurately calculated prisms on seven transmission surfaces . . . incorporates a silvered glass reflector at the top which directs the light downward.

Made of cast aluminum, gasketed and weatherproofed, the Pharos opens on concealed hinges for easy relamping, easy maintenance. It is rated at 200 watts, utilizing a standard A-25 lamp.



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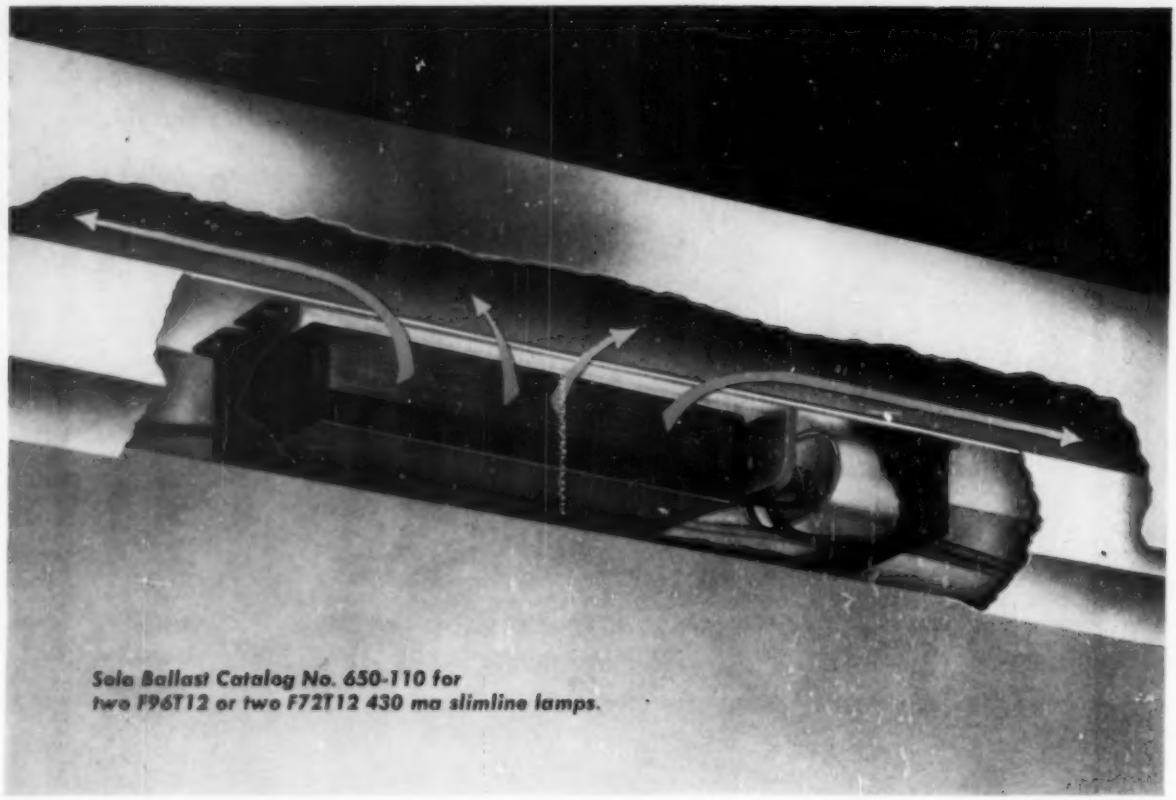

Sola Ballast Catalog No. 650-110 for two F96T12 or two F72T12 430 ma slimline lamps.

Upside-down insides make Sola's new slimline ballast work cooler, dissipate heat faster

Heat, the big enemy of fluorescent ballasts, is well on its way out thanks to a simple but extremely effective move by Sola ballast engineers. They mounted the components of their slimline ballast *upside-down*. This allowed them to remove the fiber insulator from the mounting surface of the ballast case. Now positioned beneath the label surface, it can't trap heat inside the case.

The normal heat generated by the core and coil is transmitted directly to the fixture housing where it is quickly conducted away. The fixture itself acts as a big cooling fin for the ballast. Additionally, a healthy margin of extra space is provided between the capacitor and the core and coil. This extends capacitor life.

All this adds up to a premium ballast that operates cooler, works more efficiently, and lasts longer. Despite this, it costs no more than conventional, hotter-running ballasts. You get premium performance now at no price penalty. The new ballast is CBM-certified to give full light output over its rated life.

You would be wise to capitalize on Sola's upside-down act when you next need ballasts for quality fluorescent fixtures, or for replacement where other ballasts gave up.

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PLANNING for the 1960 National Technical Conference in Pittsburgh is the Conference Executive Committee at its October 19 meeting. Left to right, outer circle: Mrs. J. P. Boyden, Jr.; C. R. Brandfass, acting for C. A. Conklin; C. D. Miller, East Central RVP; J. Carl Wilson, National Vice Chairman, 1960 Conference; A. D. Hinckley, Managing Director; N. C. Warner, Chairman, Executive Committee; G. H. Maize; C. L. Amick, National Chairman, 1960 Conference; D. W. Loucks; F. J. Powers; J. P. Boyden, Jr. Inner circle: H. R. Jones; D. C. Thomas, Chairman, Pittsburgh Section; C. M. Crysler; J. A. Hodges. Committee members missing from photo: H. Briggs, Jr.; F. E. Duckworth; R. G. MacDonald; G. W. Provost and O. C. Brinkerhoff. The committee plans monthly meetings in preparation for "the best Conference yet."

(Continued from page 18A)

and development stages. In this country three atomic plants are now in operation, with 16 more already planned and 11 major research and development projects in operation. Russia does not plan any large scale atomic power plant development until it is possible to produce energy from atomic fuels as economically as from conventional fuels.

Industrial purposes claim 80 per cent of the electricity produced in the Soviet Union; the remaining 20 per cent being used for commercial establishments, farms and homes. Average home use of electricity there is 400 kwh a year, compared to the 1958 United States average of 3400 kwh. Electricity for the home costs four cents a kilowatt-hour in the USSR. In the United States a sliding scale is used, with an average price of 2.53 cents per kwh.

There are 52 power systems in all of the Soviet Union, many of them individual plants not interconnected with a grid. In European Russia three primary systems produce 6 or 7 million kilowatts each. At some future time, these systems will be linked with other systems in European Russia and the six systems in Central Siberia to form a single power grid.

In a number of instances, according to Mr. Vennard, Russian growth has been greater than ours, in terms of per cent increase. Much of this, he continued, is due to the low level of the starting point, some to the different state of development of the two economies and some to the manner in which growth can be engineered by the planners.

The American visit to the Soviet Union, which provided the basis for Mr. Vennard's testimony, was sponsored by the Edison Electric Institute and the Association of Edison Illuminating Companies, under the auspices of the Department of State. The Soviet Ministry of Construction of Power Stations was host to the group, which visited 15 electric power plants and four heavy electrical equipment factories.

NEMA Named Administrator For Medallion Home Program

National responsibility for the administration of the Medallion Home Program will be assumed in 1960 by the National Electrical Manufacturers Association, a move recently approved by the NEMA membership. Acceptance of this responsibility is a key link in the reorganization of the Association which will result in a more active business development policy in the interests of the 500-plus member companies.

For the Medallion Home Program, NEMA will provide headquarters staff to make certain that standards set or revised by local utilities meet established minimums; provide promotional material; make available to participating utilities a continuing supply of Gold and Bronze Medallions and prevent unauthorized use of the Medallions.

Medallion Homes, initiated by the Live Better Electrically Project in 1958, has aimed to establish industry standards for appliances, lighting and wiring in new and remodeled homes. It is estimated that over 6500 home builders have been signed up by local utilities for participation in the program. These builders have agreed to build homes meeting Medallion Home electrical specifications set by their respective local public utilities.

ABOUT PEOPLE

According to a recent announcement, **H. B. Paxton** has been elected vice president in charge of finance for the Appleton Electric Co. of Chicago, Ill. Prior to this appointment, Mr. Paxton served as assistant general manager in one of Curtiss-Wright's large plants. His earlier business experience was with Arthur Young and Co., a national firm of certified public accountants situated in Chicago. Another Appleton announcement names **Chester B. Hudgins** manager of systems planning and controls, a newly created post at the company.

Day-Brite Lighting, Inc. has announced the appointment of **Bart M. Jordano** to the position of sales representative in the Minneapolis—St. Paul, Minn. area. Mr. Jordano, who was in lighting sales for the Commercial and Industrial Department of the Central Hudson Gas and Electric Co., a utility located in Poughkeepsie, N. Y., has been the Day-Brite representative in Washington, D. C. for the past year. Day-Brite has also named **George N. Maloomian,** a former representative of Curtis Lighting, Inc., sales representative in the Washington, D. C.—Baltimore territory. The company's former Baltimore representative, **Samuel Masland,** retired November 1 after 32 years with Day-Brite.

Results of the election of officers of the Producer's Council for the 1959-1960 year, held during the Council's 38th Annual Meeting in St. Louis, have been announced. Reelected for one year terms are: President—**H. Dorn Stewart,** Barrett Division, Allied Chemical Corp.; First Vice-President—**E. A. Lundberg,** Pittsburgh Plate Glass Co.; Second Vice-President—**H. E. North, Jr.,** Arcadia Metal Products; Secretary—**T. D. Wakefield,** The Wakefield Co.; Treasurer—**H. L. Cramer,** Westinghouse Electric

(Continued on page 22A)

CONNECTICUT Section's opening meeting featured currently hot subject of "Esthetics in Lighting." Participating in this successful program were, from left to right, C. W. McCormick, speaker Gerald Ewing and Section Chairman, W. P. Carpenter.

FIRST on circuit for the Progress Report was New Jersey Section. Progress Committee Chairman, E. A. Linsday, brought the show to Newark for the Section's opening meeting, October 14.

(Continued from page 21A)

Corp. Reelected for two-year terms as Directors are: **R. W. Lear,** American Radiator and Standard Sanitary Corp.; **Douglas Whitlock,** Structural Clay Products Institute; **D. J. Boone,** Zonolite Co.; **J. B. Duff,** Sargent and Co.; **Marvin Greenwood,** The Celotex Corp.; **F. B. Peckham** U. S. Plywood Corp.; **D. A. Rothrock,** Rohm & Haas Co. and **Max Schoetz,** Aluminum Co. of America. Newly-elected to Board of Directors for two-year terms are: **George Martens,** Johns-Manville Sales Corp. and **J. O. Heppes,** U. S. Ceramic Tile Co.

Joseph S. DeMaio has joined the Corning Glass Works of Corning, N. Y. as advertising and sales promotion manager of the Electrical Products Division. Mr. DeMaio has been associated with the R. H. Donnelley Corp. and the National Gypsum Co. of Buffalo, N. Y., and The Carborundum Co. of Niagara Falls, N. Y.

William J. Pietenpol, divisional vice president and general manager of Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corp., has announced the appointment of **S. George Lawson** to the newly created position of operations manager for the Semiconductor Division. Mr. Lawson, who will be located at Division headquarters, has been operations manager in charge of photolamp and incandescent lamps for Sylvania's Lighting Products Division since 1956. His new duties include overall responsibility for the Semiconductor Division's production planning, purchasing, manufacturing, inventory control and selection activities. Sylvania Lighting Products, has a new operations manager—incandescent and photoflash lamp manufacturing — **William B. O'Keefe,** who will have complete responsibility for Sylvania incandescent and photoflash manufacturing in Massachusetts, Pennsylvania, and Kentucky. He has been vice president — manufacturing for Sylvania Electric (Canada), Ltd. in charge of photoflash, incandescent and fluorescent lamp and radio tube manufacturing in Drummondville, Canada. The appointment of **Robert R. Walker** as public relations manager of Sylvania Lighting Products was also announced. Mr. Walker previously operated his own public-relations company in the Boston area. In his new capacity, he will be located at the Salem, Mass., headquarters of Sylvania Lighting Products.

Westinghouse Lamp Division, Bloomfield, N. J., has announced the appointment of **Raymond J. Stefany** as manager of government and aviation lamp sales. Mr. Stefany, who will have offices in Washington, D. C., replaces **R. J. A. Kaemmerer,** who is retiring. In his new position, Mr. Stefany will be responsible for relations with various government agencies as well as for aviation lamp sales, including lighting products and systems relating to airport approach lighting, runway systems, and aircraft identification and directional beam systems. He is currently chairman of the IES Aviation Ground Lighting Committee.

Jerry J. Silvers has been made national sales manager of the Globe Illumination Co. of Los Angeles, Calif., a commercial and industrial lighting equipment firm. Previously an engineering sales manager, Mr. Silvers joined Globe in 1952 as head of the engineering department and later headed the local sales department.

At the October 13 meeting of the British Illuminating Engineering Society, held in London, **H. G. Campbell,** M.A., M.I.Mech.E., F.I.E.S., was installed as president of the Society for 1959-60. Mr. Campbell is managing director of Benjamin Electric, Ltd. and a director of Holophane, Ltd.

W. G. Warne was named production control manager of Precision Transformer Corp., Chicago, Ill. Formerly, he was production and materials control manager at the Pennsylvania Transformer Division of McGraw-Edison in Canonsburg, Pa. He was an executive with the firm for 12 years.

Christian Heidt has been named director of sales for Duro-Test Corp., North Bergen, N. J. Mr. Heidt joined Duro-Test in 1952 as sales manager and in 1957 he became general sales manager.

A new electrical engineering office, Omer J. DeBever & Associates, has been established in Los Angeles by the former chief electrical engineer for Charles Luckman Associates, **Omer J. DeBever.** Prior to joining Charles Luckman (then known as Pereira & Luckman), Mr. DeBever was affiliated with the architectural and engineering firms of Welton Becket & Associates, Donald R. Warren Co., Bechtel Corp., Ralph M. Parsons Co., and Holmes

(Continued on page 25A)

Gotham Lighting Corporation announces a new group of recessed fresnelens downlites with wide-angle distribution[1] to meet the needs of architects, designers and engineers. These units combine optically engineered Alzak reflectors with exclusive Gotham fresnelenses[2] to produce high efficiency[3] and comfortable brightness. Twist-lock fastened[4] hinged doors are featured in all units, adding to the clean appearance by eliminating visible hardware. Two series of downlites comprise the groups: Series 5000[5] which have lenses set flush with the ceiling, and Series 5100[5] with lenses regressed above the ceiling plane.

Cross-section of typical 5100 Series unit

1
For uniform illumination, these downlites can be installed so that the space between units is the same as the height of the ceiling above the work plane.

2
Extensive optical research led to a development of exclusive lenses based on a new concept in prism contour and rear surface pattern. These lenses, coupled with mathematically derived Alzak reflectors, produce a significant advancement in performance over conventional fresnelens units.

3
Efficiencies for the 5000 series range from 61.5% to 71.5%, and from 56.5% to 68.5% for the 5100 series (by E. T. L. test).

4
The twist-lock fastened door can be opened by hand or by pole from the floor for relamping and maintenance.

5
For complete data, write:

GOTHAM LIGHTING CORPORATION
37-01 Thirty-first Street
Long Island City 1, N. Y.

KOPP Lighting Glassware, Lenses, Color Filters

Color...light...heat...strength...dimensions...
Engineered to meet your specific needs

Kopp engineering designs lenses, color filters or specialized lighting glassware to meet a wide variety of needs. This includes developing the formula to provide accurate color and the right light transmission and distribution.

It involves the design and production of moulds and establishing controlled manufacturing procedures for custom production. Tempering and other finishing operations assure specialized properties to withstand physical stresses or unusual environmental conditions.

In some cases, Kopp suggests design alterations to give you better performance and lower cost. That's why it pays to contact us early, before your design specifications are finalized. *Ask for bulletin on Kopp Engineered Glass.*

Products illustrated, from the top:

- **Round Flat Fresnel Lens**
- **Aircraft Warning Light Cover**
- **Floodlight Cover Glass**
- **Railroad Roundel**
- **Airport Runway Lens**
- **New 12" Dia. Traffic Signal Lens**
- **Underwater Swimming Pool Lens**
- **Cylindrical Fresnel Lens**

KOPP GLASS

Kopp Glass, INC.

Swissvale, Pennsylvania

(Continued from page 22A)

& Narver. In addition, he was a senior staff electrical engineer and liaison officer to the director of engineering, United States Atomic Energy Commission.

Thomas Industries, Inc. of Louisville, Ky., has established a new Export Department, which will market the products of each of the company's three major divisions on an international basis. **Hal Myers,** who will head the new division, was a representative of Borg-Warner International Corp. and Butler Pan-America Co. He also spent three years in Caracas, Venezuela, as a representative of the International Basic Economy Corp.

Leo Dolkart, a charter member of IES, has announced his availability for consultation and work concerning illumination for commercial and industrial plants, design of substations, street lighting and maintenance, estimation of electrical construction costs, and design of light and power distribution for industrial and commercial plants. Mr. Dolkart is an electrical engineer with many years of design and construction experience.

The appointment of **William Parkerson** as supervisor of statistics at the Edison Electric Institute has been announced. Mr. Parkerson, who has more than 35 years of experience in utility statistics and rate matters, will work with **John Thornborrow** in the Department of Economics and Statistics.

The Ward Leonard Electric Co., Mount Vernon, N. Y., announced the appointment of **Charles B. Durling** as district manager of the Chicago office. Mr. Durling succeeds **Kline Gray,** who has retired. In addition, **W. L. Patton** was made district manager of the Pittsburgh office and **Robert Peterson** takes over as St. Louis district manager.

Clarence T. Evans, consulting electrical engineer for Cutler-Hammer, Inc., Milwaukee, Wis., was honored during the NEMA convention November 12, in recognition of his "devoted half century of service to the electrical industry." The occasion was the closing general luncheon of the 33rd Annual Convention of the National Electrical Manufacturers Association, at which Mr. Evans was presented with a 50-year award. At the closing session of the convention, **N. J. MacDonald,** of Elizabeth, N. J., president of The Thomas & Betts Co., was also elected president of the Association. He is also chairman of the industry's annual observance, National Electrical Week, and formerly served as chairman of the Executive Committee of the National Wiring Bureau —an industry-wide organization interested in furthering the adequate wiring of homes, commercial and industrial structures. Mr. MacDonald, who was a vice president of the group, succeeds **J. L. Singleton** of Milwaukee, Wis., senior vice president, Industries Group, Allis-Chalmers Manufacturing Co. The new NEMA vice president is **W. C. Wichman,** of Chicago, Ill., vice president of General Electric Co., and general manager of the company's Hotpoint Division; **A. D. R. Fraser,** of Rome, N. Y., president of Rome Cable Corp., was elected treasurer.

PAST-CHAIRMAN Pins for all former chairmen is a project of the Cornhusker Section. Some of the recipients of this honor, shown at the Section's Fall Lighting Conference in Columbus, Nebr., are, l. to r.: C. P. Haas, Chairman, 1955-1956; C. R. Tracy, Chairman of original Nebraska-Iowa Chapter; G. D. Mittauer, first Chairman, Cornhusker Chapter, and M. E. Lee, 1957-1958.

Kenneth D. Cummings has been appointed assistant sales manager for the Moe Light Division of Thomas Industries, Inc., Louisville, Ky. Mr. Cummings has been associated in sales with Thomas Industries since 1950, when he joined the company as sales representative for the San Francisco territory. More recently, he was district manager in the Seattle, Wash., area.

Pfaff & Kendall, Newark, N. J., have named **William B. Gile** & Associates as exclusive sales representatives for North and South Carolina, with headquarter offices in Charlotte.

Abolite Lighting has announced the appointment of **Dan H. Radke** Co., San Francisco, Calif., as their northern California representative.

The purchase of the transportation product line of the Delta-Star Electric Division, **H. K. Porter** Co., Inc., has been announced by Trans-Lite, Inc. of Milford, Conn., manufacturers of lighting equipment for the transportation industry. Trans-Lite, Inc. is the successor to the Lighting Division of Safety Industries, Inc., formerly of Hamden, Conn.

Deaths

Joseph M. Bergeson, Inland Empire Chapter
Fred J. Buchal, Chicago Section
Edith Hitchcock, Alabama Section
Charles A. Jaqua, Indiana Section
J. R. Kotsmith, Twin City Section
C. P. Merklin, Oregon Section
Earl F. Mullen, Twin City Section
Frank H. Peterman, Philadelphia Section
M. A. Polster, Maryland Section
Fred R. Smith, Oil Capital Section
Willibald Weniger, Oregon Section

BOOKS AND PAMPHLETS

The A-B-See of Modern School Lighting, by Bill F. Jones, published by Smoot-Holman Co., 321 North Eucalyptus Ave., Inglewood, Calif., 24 pp., $1.00.

The amount and quality of light needed for the performance of various school tasks and methods of achieving desired results are discussed in this booklet. Both natural and artificial light are investigated and illustrations of various types of lighting fixtures, with a performance chart, are provided.

The booklet is divided into two sections, of which the first concerns itself with

(Continued on page 26A)

FORTIETH anniversary with his company was celebrated for IES Fellow Henry L. Logan, left, at recent luncheon in his honor. Plaque commemorating his distinguished service to Holophane Co., Inc., is being presented by Charles Franck, president of the company.

(Continued from page 25A)

classroom lighting and examines the problems of amount of light required for easiest studying and effect of glare and brightness, giving recommended reflectance values for proper classroom conditions. Photographs showing the decreased seeing efficiency caused by glare and unwanted reflections from fixtures, as well as a comparison chart of ten different types of lighting fixtures, are presented in this section. The second section deals with 16 types of fixtures commonly used for areas other than classrooms; recommendations for use are included.

Free copies of the booklet are available to persons having direct or indirect responsibility for specifying school lighting.

ALA Consultant, published by Large Lamp Department, General Electric Co., Nela Park, Cleveland, Ohio, 75 cents.

Official publication of the Academy of Lighting Arts, this periodical is written specifically for people in the residential lighting field. Vol. 1, No. 1 includes articles on an outstanding residential lighting installation, techniques of structural lighting, new equipment and news of the Academy.

Analysis of 1959 Revision of National Electrical Code, by Howard Michener, available from National Electrical Manufacturers Association, 155 East 44th St., New York 17, N. Y., 107 pp., 50 cents.

To assist Code users in comparing the 1956 and 1959 editions of the National Electrical Code, Mr. Michener, assistant manager of the NEMA Engineering and Safety Regulations Department, has prepared this analysis of Code changes approved since the last edition. The new 1959 Code contains a considerable number of changes in substance, as well as a complete revision in format.

Classification and Definition of Diagrams and Charts Used in Electrotechnology, First Edition, Publication 113, International Electrotechnical Commission, $1.20.

Internationally-accepted standard definitions and classifications of diagrams and charts of electrical and electronic connections are published for the first time in this book. Classifications are in two forms—according to purpose and according to method of presentation.

The International Electrotechnical Commission, compiler of the book, is a 34-nation body founded in 1904 to coordinate national electrotechnology standards. The U. S. National Committee of IEC, a branch of the American Standards Association, represents United States interests in the IEC.

Copies of this publication can be secured from Dept. PR 99, American Standards Association, 70 East 45th St., New York 17, N. Y.

Defense Research and Development Contracts Guide, Jesse L. Lewis, Editor; published by Vincent F. Callahan, Evans Bldg., Washington 5, D. C., 150 pp., $25.

A non-technical source book for businessmen, this report on the $5½ billion program of research and development authorized by the U. S. Department of Defense, Advanced Research Projects Agency, Army, Navy and Air Force, gives advice and information on how to obtain government contracts. Special feature of the book is a map of the United States showing locations of 228 military installations which give research and development contracts. State maps of such facilities, specific data on the activities carried on by each station and names of contracting officers and small business specialists are also included.

Jesse L. Lewis, Lt. Col. U. S. Army, Ret., who edited the Guide, is editor of the weekly publication *Defense R & D Contracts Report.*

Farm Electric Sales Handbook, published by Farm Group, Edison Electric Institute, 750 Third Ave., New York 17, N. Y. 66 pages; loose-leaf; $3.50 plus postage.

Designed for use by rural salesman of electric power companies, electric equipment manufacturers and agricultural extension services of colleges, the book contains information on various applications of electricity on the farm. Subjects covered include electrical equipment for the farm shop, dairy, brooding, egg cooling; underfloor electric heating cables; sprinkler and irrigation systems. Advantages of the electrical equipment are discussed and data on costs and average kw-hr use are also included.

EEI's Farm Group plans to publish additions to the book from time to time.

Commercial Standards, Catalog No. 978, published by Commodity Standards Division, U. S. Department of Commerce, Washington 25, D. C.; no charge.

The new list of commercial standards, revised to July 1, 1959, is now available from the Department of Commerce. The index lists all commercial standards in 22 classifications including, among others, electrical and mechanical equipment, plastics, and heating, ventilating and refrigerating equipment. A supplement lists new standards in preparation and existing standards under revision.

(Continued on page 28A)

SINKO LOUVERS offer COLOR harmony

NEW "HAPPY" EMPHASIS ON NEW YORK'S GAY WHITE WAY

To produce 4 to 5 times the illumination found in most stores, Silvray Fixtures with Sinko Colored Louvers were used with outstanding success in Barton's Candy Corporation Shop at 7th Avenue and 47th Street in New York, and since then in a second store at 77th Street and Madison Avenue.

This is primarily an indirect lighting system which bounces two-thirds of the light from the ceiling. The other one third of the illumination comes directly from the Power Groove Fluorescent Lamps shielded by Sinko Colored Louvers.

Silvray's Color-ceil system achieves a luminous floating panel effect through the use of Sinko Yellow Louvers (plastic drop-in panels) placed between the modular lighting units. The panels take on a warm color glow from the reflected ceiling light. Shadowless, "happy" comfortable light in the 200 footcandles range was obtained. (Ordinary store lighting seldom exceeds 40 to 50 footcandles).

Since the installation, it has been found that the Sinko Louvers add to cleanliness and have made the lighting "easy on the eyes" thus improving efficiency and relieving fatigue.

Use Sinko Colored Louvers on your next job for "happy" results. Write for bulletin.

SINKO THIN-CELL louvers

SEE OUR CATALOG IN SWEET'S

produced and sold by

SINKO MANUFACTURING AND TOOL CO.
7310 W. WILSON AVE., CHICAGO 31, ILL.

(Continued from page 26A)

Commercial standards are voluntary standards developed at the request of industry, to provide a basis for fair competition.

Symposiums of the 2nd National Lighting Exposition, available from National Lighting Expositions, 550 Fifth Ave., New York 36, N. Y., $5.00.

Transcriptions from tape of talks given during the Symposiums of the National Lighting Exposition, March 1-4, 1959, at the New York City Coliseum, are available in multi-lithed form. The talks, all by well-known authorities in the lighting field, cover such topics as office lighting, street and highway lighting, light and architecture, institutional lighting and lighting for selling, industry, theatres and recreation.

Why Automation?, published by National Office Management Association, 1931 Old York Road, Willow Grove, Pa., $5.00.

This booklet reports the effect of automation on offices, based on the experiences of 369 companies who installed automated data processing machines. The report details the factors involved in the decision to adopt automation and the effects automation has had on company growth. Copies of the complete report, including the NOMA Automation Bibliography (a classified bibliography on automation), may be secured from NOMA at the above address.

Area Floodlighting Made Easy! available from Crouse-Hinds Co., Syracuse 1, New York, 16 pages. Free.

Reference guides for selecting incandescent or mercury floodlights, general purpose or heavy-duty types, and for determining how many floodlights are needed based on the size of the area to be lighted are contained in this booklet, thus simplifying lighting plans for parking areas, construction sites, shopping centers, farm yards and other open areas.

Footcandle charts and installation diagrams are included, along with listings of floodlights and mounting accessories.

Writing and Publishing Your Technical Book, published by F. W. Dodge Corp., 119 West 49th St., New York 18, N. Y.

Tips on how to plan and prepare manuscripts for technical books, how to contact publishers and other details of the business of writing a book are contained in this 50-page booklet available, without charge, from the publisher.

Seminars on Engineering Education, published by Iowa State University, Ames, Iowa, 34 pages.

Designed to aid the counsellor of high school students, this booklet is a report on a seminar on engineering education, held at Iowa State University last May. Included are talks by Dr. Glenn Murphy, head of theoretical and applied mechanics, and by Dr. E. W. Anderson, head of of aeronautical engineering, and a report on the discussion groups held after the talks. A limited number of booklets are available on a first come, first served basis, from the Dean of Engineering at the University.

Guide for Loading Dry-Type Distribution and Power Transformers, C57.96, published by and available from the American Standards Association, Dept. PR 107, 70 East 45 St., New York 17, N. Y., $1.35.

Intended as an appendix to the C57.12 series of standards for power and distribution transformers, but not as part of them, the C57.96 guide covers general recommendations for the loading of dry-type distribution and power transformers that have insulation systems limited to 150C and 220C maximum hottest-spot operating temperatures. The guide includes recommendations for both ventilated and sealed, nitrogen-filled, dry-type transformers.

American Standard Physical and Electrical Characteristics of 400-Watt BT-37 (H1) Fluorescent Mercury Vapor Lamp, C78.1304-1959; **400-Watt BT-37 (H1) Mercury Vapor Lamp,** C78.1305-1959, available from the American Standards Association, Dept. PR 97, 70 East 45 St., New York 17, N. Y., 35 cents each.

The American Standards Association has made available two approved revisions of standards on 400 watt mercury vapor lamps, which are being used at an increasing rate for street and factory lighting. Physical characteristics discussed in both standards are base and bulb designations, dimensions and temperature limits. Operating characteristics include lamp volts, lamp current amperes, lamp watts, and sustaining volts.

American Standard Specification for Rigid Steel Conduit, Zinc-Coated, C80.1-1959; **Rigid Steel Conduit, Enameled,** C80.2-1959; **Electrical Metallic Tubing, Zinc-Coated,** C80.3-1959, available from the American Standards Association, Dept. PR 104, 70 East 45 St., New York 17, N. Y. 80 cents each.

Revisions of the three basic standards for metal conduit and tubing for electrical raceway systems have been approved by the American Standards Association. Of interest to contractors and other users of electrical wiring, as well as to manu-

(Continued on page 30A)

1960 Regional Conferences — IES

Region	Place	Date
South Central and Southeastern	Peabody Hotel Memphis, Tenn.	April 21-22
Southwestern	Robert Driscoll Hotel Corpus Christi, Texas.	April 25-26
Inter-Mountain	Westward Ho Hotel Phoenix, Ariz.	April 28-29
South Pacific Coast	Ambassador Hotel Los Angeles, Calif.	May 4-6
Pacific Northwest	Benjamin Franklin Hotel Seattle, Wash.	May 9-10
Midwestern	Sheraton Martin Hotel Sioux City, Ia.	May 12-13
Great Lakes	Carter Hotel Cleveland, Ohio.	May 16-17
Northeastern	Wentworth-By-the-Sea Portsmouth, N. H.	June 8-9
Canadian	Nova Scotian Hotel Halifax, N. S.	June 13-14

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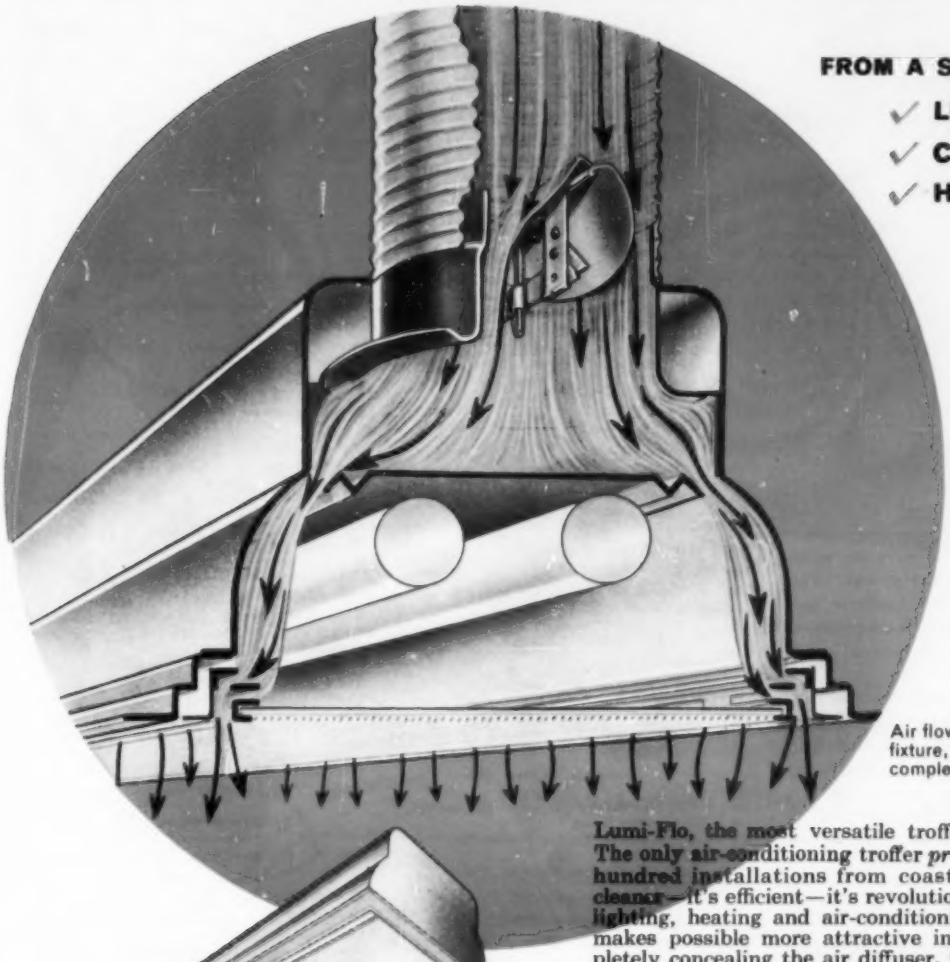
LUMI-FLO

the proven 3 in 1 troffer

FROM A SINGLE SOURCE

- ✓ Lighting
- ✓ Cooling
- ✓ Heating



Air flows from duct through fixture, by-passing lamps completely.

Available in a variety of styles with glass or plastic lenses and aluminum or plastic louvers.

Lumi-Flo, the most versatile troffer ever created. The only air-conditioning troffer *proven* in over one-hundred installations from coast to coast—it's cleaner—it's efficient—it's revolutionary. Combined lighting, heating and air-conditioning in one unit, makes possible more attractive interiors by completely concealing the air diffuser, thus eliminating cluttered ceilings.

Developed and tested by the most respected name in the lighting industry, the Lumi-Flo troffer offers new engineering freedom for those who design with light.

For fixture engineering at its finest, look to Benjamin. Your local Benjamin representative will be happy to help you. Contact him on any problem ...large or small.

BENJAMIN

ELECTRIC MFG. CO., Des Plaines, Illinois

Subsidiary of THOMAS INDUSTRIES INC

BENJAMIN · MOE LIGHT · STAR LIGHT · ENCHANTE · SAN MARINO

RETIRING Golden Gate Section Chairman John C. Epperson (left) is presented with transistor radio in appreciation of his leadership during an eventful Section year which included sponsorship of the National Technical Conference. Incoming Chairman Walter G. Bayha conveys the Section's thanks as South Pacific Coast Regional Vice President James E. Barnes (far left), J. W. Richardson (second from right), speaker at the meeting and Arthur S. Tylor, Section Secretary, look on.

(*Continued from page 28A*)

facturers, the standards cover zinc-coated rigid steel conduit, enameled rigid steel conduit, and zinc-coated electrical metallic tubing used as raceways for the wires or cables of an electrical system. The American Iron and Steel Institute and the National Electrical Manufacturers Association sponsored this activity under ASA procedures.

Manufacturers, consumers, technical societies and government agencies are represented on the ASA sectional committee that developed and revised the standards, which include tables of dimensions and weights, coatings, and identification, as well as test and inspection procedures.

NEW MEMBERS

At the meeting of the IES Council on November 19, 1959, the following were elected to membership. Names marked * are transfers from Associate Member grade.

ALABAMA SECTION

Associate Members:

Haskins, J. L., Gulf Power Co., Pensacola, Fla.
Marshall, Seymour, Gulf Electric & Hardware Co. Pensacola, Fla.
Snyder, S. W., Alabama Power Co., Mobile, Ala.

ARIZONA SECTION

Member:

Fahlen, F. T., Jr., Arizona Public Service Co., Phoenix, Ariz.

Associate Members:

Gray, C. P., Arizona Public Service Co., Avondale, Ariz.
Inman, L. M., Jr., Arizona Public Service Co., Casa Grande, Ariz.

ARKANSAS CHAPTER

Member:

*Hughes, Maury, Jr., Leo L. Landauer & Associates, Little Rock, Ark.

ARK-LA-TEX CHAPTER

Associate Member:

Jardes, A. L., Jr., S & H Electric Co., Inc., Shreveport, La.

ARROWHEAD CHAPTER

Associate Members:

Burris A. L., California Electric Power Co., Barstow, Calif.
Bush, J. W., Tri-County Electrical Wholesalers, San Bernardino, Calif.
Cox, J. A., California Electric Power Co., West Riverside, Calif.
Mang, J. J., California Electric Power Co., Corona, Calif.

BUCKEYE CHAPTER

Associate Members:

Anderegg, E. R., Thomas Industries, Inc., Louisville, Ky.
Bellamy, W. N. Jr., Columbus & Southern Ohio Electric Co., Columbus, Ohio.
Bush, F. E., Pratt & Bush Electrical Sales Co., Inc., Columbus, Ohio.
Cathers, R. C. Ohio-Midland Light & Power Co., Canal Winchester, Ohio.
Kessler, A. V., W. E. Metzger & Associates, Columbus, Ohio.
King, W. A., Sylvania Electric Products, Inc., Columbus, Ohio.

CENTRAL KANSAS CHAPTER

Associate Members:

Herink, Arleigh, Flint Hills Rural Electric Co., Council Grove, Kans.
Johnston, J. E., Compco Corp., Mitchell Lighting Division, Wichita, Kans.

CENTRAL NEW YORK SECTION

Associate Members:

Fairbanks, K. E., Corning Glass Works, Corning, N. Y.
Lum, W. S., Crouse-Hinds Co., Syracuse, N. Y.

CENTRAL OKLAHOMA CHAPTER

Associate Member:

Dunlop, P. U., Oklahoma Gas & Electric Co., Oklahoma City, Okla.

CHICAGO SECTION

Associate Members:

Berg, R. L., Corn Products Co., Chicago, Ill.
Matulionis, Janine, Uarco, Inc., Chicago, Ill.

CHINOOK CHAPTER

Associate Members:

Andersen, A. S., Calgary Public School Board, Calgary, Alta.
Louie, E. G. L., City of Calgary, Electric Light Dept., Calgary, Alta.
Ramsey, G. L., Electric Service League of Alberta, Calgary, Alta.

CLEVELAND SECTION

Associate Members:

Blossom, H. H., Union Properties, Inc., Cleveland, Ohio.
Crissey, G. M., Cleveland Electric Illuminating Co., Cleveland, Ohio.

COASTAL BEND CHAPTER

Associate Member:

Mull, J. R., Westinghouse Electric Supply Co., Corpus Christi, Texas.

CONNECTICUT SECTION

Associate Member:

Jaeger, J. M., General Electric Co., New Haven, Conn.

CORNHUSKER SECTION

Associate Members:

Hinrichsen, K. D., Crescent Electric Supply Co., Sioux City, Ia.
Johnson, Norma E., Warren Electric Co., Sioux City, Ia.
Roberti, Vittorio, Leo A. Daly Co., Omaha, Nebr.
Tice, G. A., Electric Fixture & Supply Co., Omaha, Nebr.

EAST BAY CHAPTER

Associate Members:

Austin, J. E., City of Oakland, Oakland, Calif.
Mattos, E. B., Curtis-Allbrite Lighting Inc., San Francisco, Calif.

FLORIDA SECTION

Member:

Laney, G. C., J. E. Greiner Co., Inc., Tampa, Fla.

GEORGIA SECTION

Associate Member:

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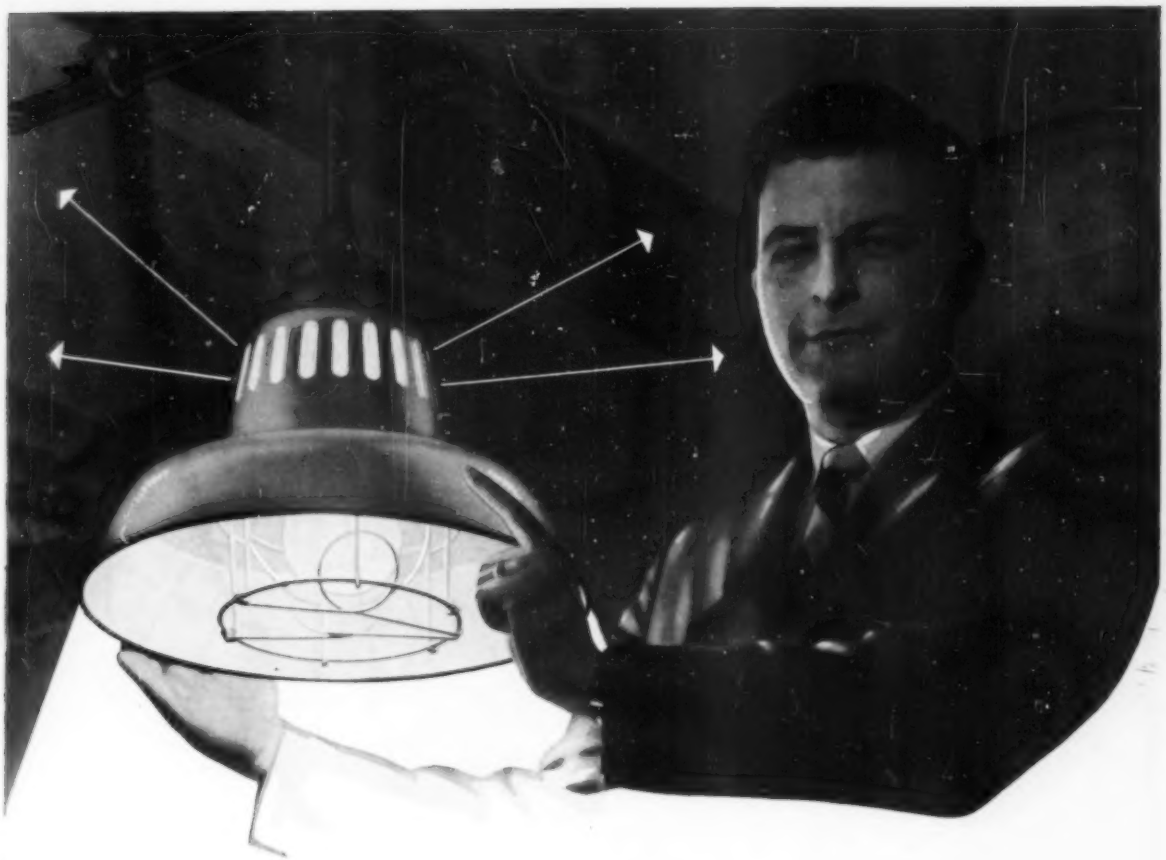

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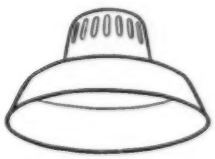

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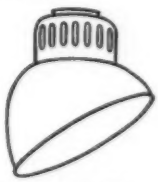

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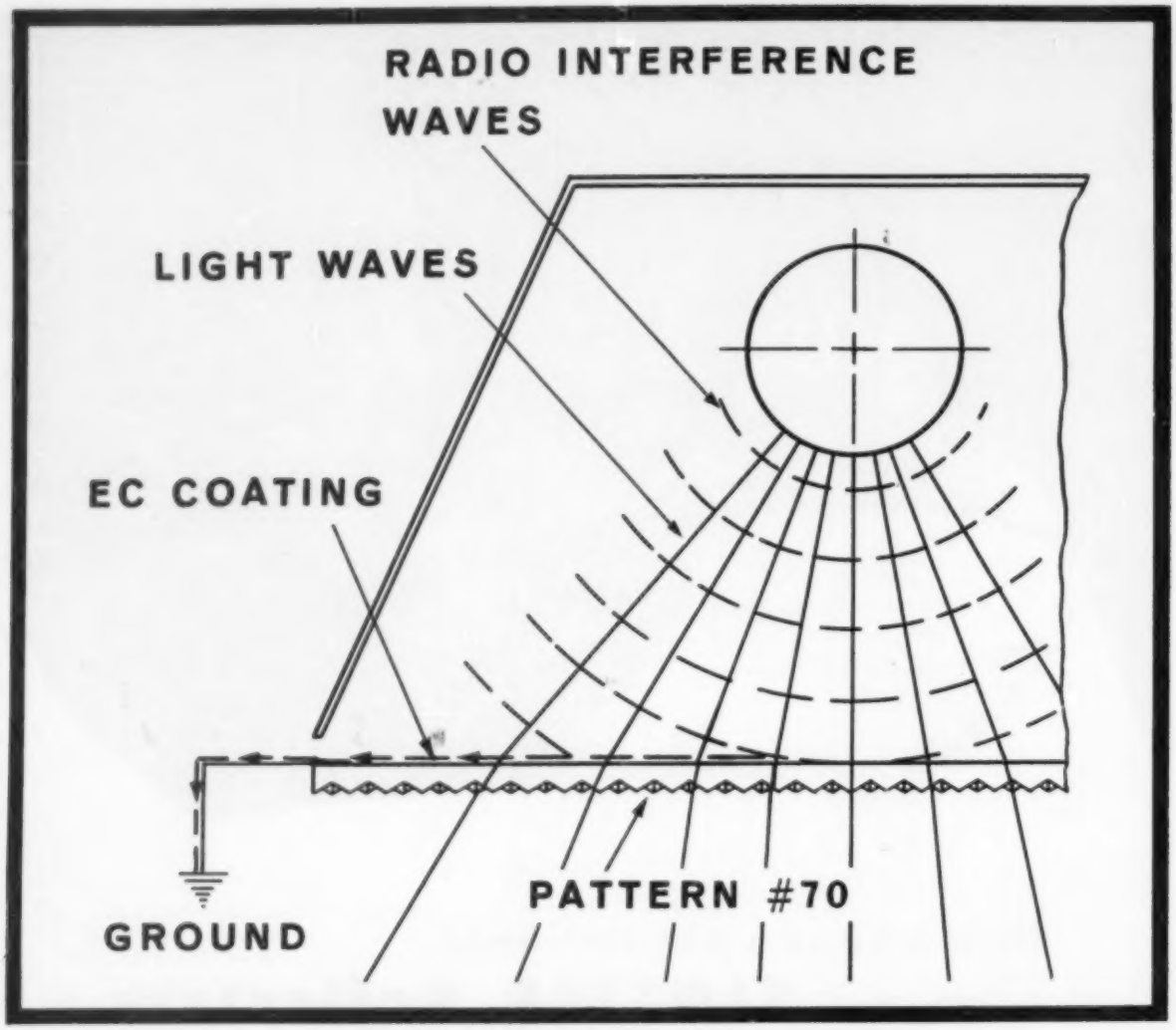

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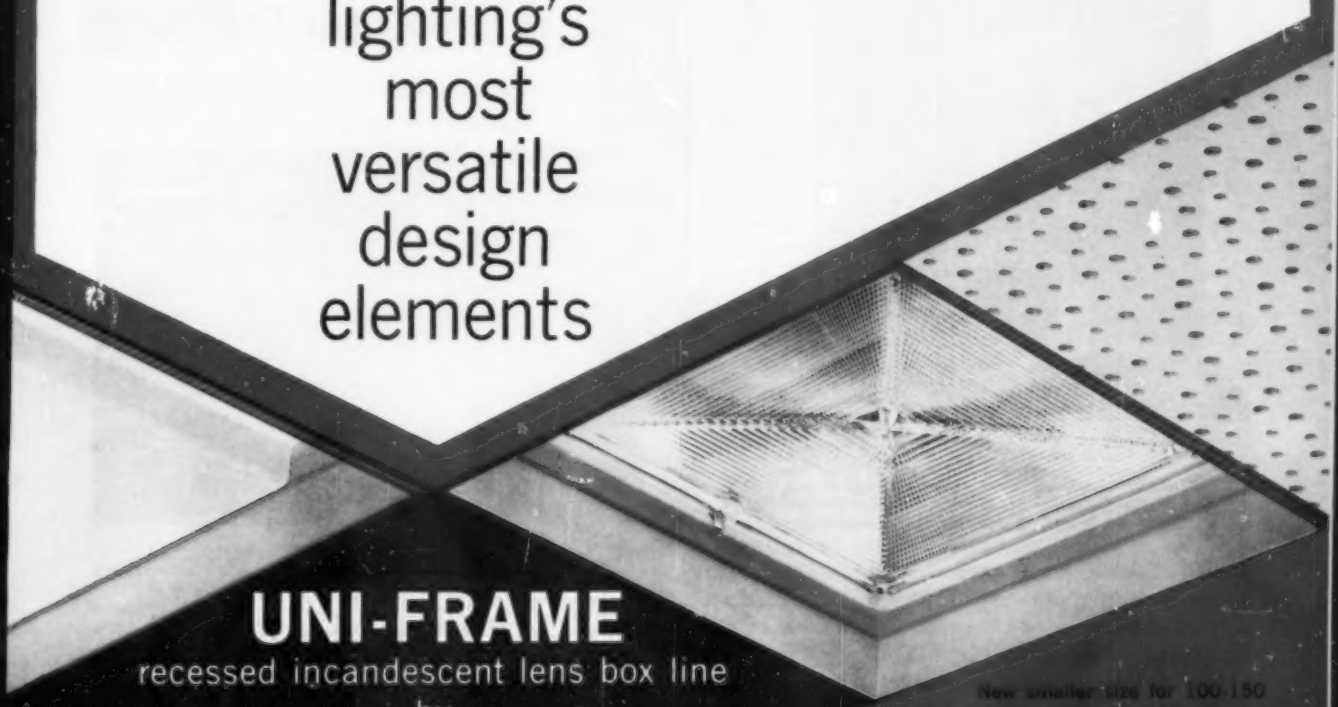

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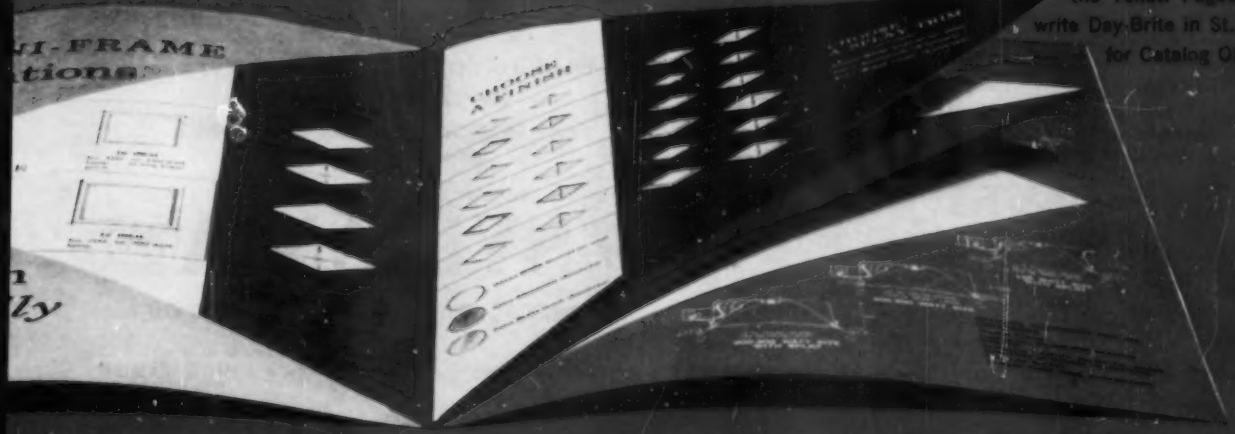

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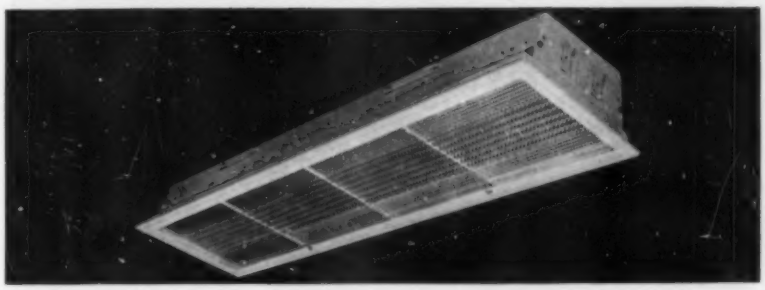

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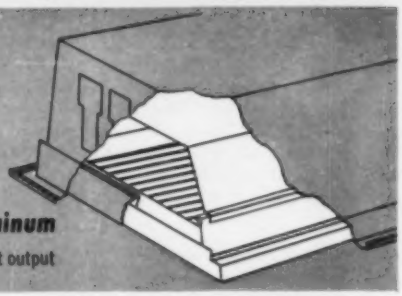

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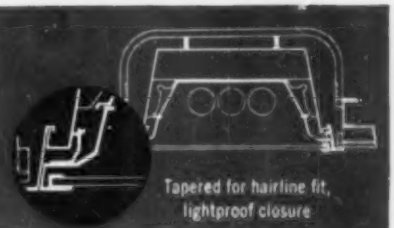

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(10) COMMERCIAL FLUORESCENT Four new, two-color catalog sheets show "Achromatic," "Wafer," "Prismalite," and "Envoy" series of fluorescent luminaires for general commercial, school, and other installations. Sheets give complete lighting calculation data and application factors, as well as other specification details. Keystone Electric Mfg. Co., Philadelphia, Pa.

(11) FLOODLIGHT CATALOG Catalog 320 is presented with four-color cover and dividers; 184 pages divided into 14 sections, each with table of contents, to give complete descriptive and ordering information. Several sections are entirely new in this company's first such catalog since 1952. Crouse-Hinds Co., Syracuse, N. Y.

(12) ALL WEATHER RECESSED UNIT Four-page, two-color folder shows company's "Contempo" series of recessed incandescent luminaires for outdoor installation in a variety of areas. Folder provides light distribution curves, reflectance factors and other technical and installation data. Marvin Electric Mfg. Co., Los Angeles, Calif.

(13) STREET LUMINAIRE Bulletin B559 describes new "Broadstreeter" outdoor fluorescent luminaire for streets, parking areas, shopping centers, etc., designed for Type III and IV light distribution, explains features and give installation and catalog data. Metalcraft Products Co. Inc., Philadelphia, Pa.

(14) HOME LIGHTING Unique, miniature 64-page catalog illustrates complete line of lighting fixtures for homes, shows more than 268 fixtures with a variety of finishes. Booklet contains complete sections on both indoor and outdoor lighting, including detailed specications on dimensions, wattage and ordering data. Progress Mfg. Co., Inc., Philadelphia, Pa.

(15) LIGHTING CONTROL SYSTEM Bulletin tells of Mark II system of lighting control for theaters, auditoriums, schools, etc., includes photographs and dimensional drawings of the dimmer units and other components, operational data, typical installation information and list of representatives. Vickers, Inc., St. Louis, Mo.

(16) SCHOOL LIGHTING Four-page, two color folder shows "Federal" line of fluorescent high-level lighting unit for schools, described as an "economy" fixture; provides details of company's other lines of fluorescent luminaires. Smitheraft Lighting, Chelsea, Mass.

(17) FLUORESCENT FLOODLIGHTS Bulletin GEC-1487B in six pages describes line of fluorescent floodlights for billboards, loading areas, highway guide signs, etc.; new rotating junction box which allows 360-degree aiming is diagramed; shows light distribution and photometric data. General Electric Co., Schenectady, N. Y.

(18) COMMERCIAL FLUORESCENT Bulletin 700 describes "Power-Lux" luminaire designed for commercial application of new, improved high ouptut lamps, explains how high intensity illumination and controlled brightness is attained through use of compound curved louvers; gives full specifications, photometric data, etc. Lighting Products, Inc., Highland Park, Ill.

(19) LUMINOUS CEILING Eight-page, three-color folder shows complete assortment of luminous ceiling styles available from this company; describes variety of hangers under several conditions; shows some typical installations. Luminous Ceilings, Inc., Chicago, Ill.

(20) REFLECTOLITES 16-page Folio R-60 contains data on 70 wall-mounted fluorescent and incandescent luminaires in this line. Catalog includes complete specifications and illustrations of these units, includes light distribution curves, and describes some typical uses. Gruber Bros. Inc., Brooklyn, N. Y.

(21) ALUMINUM LIGHT STANDARDS New 32-page, two-color catalog of aluminum alloy lighting standards gives detailed descriptions, dimensions and illustrations of types with various bracket styles; for flood lighting, lamp posts and traffic; shows typical installations. Hubbard and Co., Chicago, Ill.

(22) RECESSED LUMINAIRE Eight-page, two-color folder describes "Holoflux" No. 6400 line of recessed fluorescent luminaires available in two lens designs for variety of commercial lighting installations. Folder provides distribution curves and other data. Holophane Co., Inc., New York, N .Y.

(23) MERCURY LUMINAIRES Bulletin GEA-6943, 12 pages, describes new line of mercury luminaires for roadway lighting, gives application data for various types with diagrams, photos and photometric data, and describes new cadmium-sulphide photoelectric control. General Electric Co., Schenectady, N. Y.

(24) TROFFER CATALOG 20-page, two-color, shows line of shallow recessed fluorescent troffer luminaires, designed for flush-mounting. Catalog provides specification, technical and installation data, and includes light distribution curves, coefficients of utilization, etc. Morris Kurtzon, Inc., Chicago, Ill.

(25) STRUCTURAL LIGHTING New Line of pre-finished structural lighting units called "Modulume" for residential and commercial applications is described in a 16-page catalog showing detailed drawings of profiles and applications of cove and valance lighting. Includes specifications and ordering data. Lam Inc., Wakefield, Mass.

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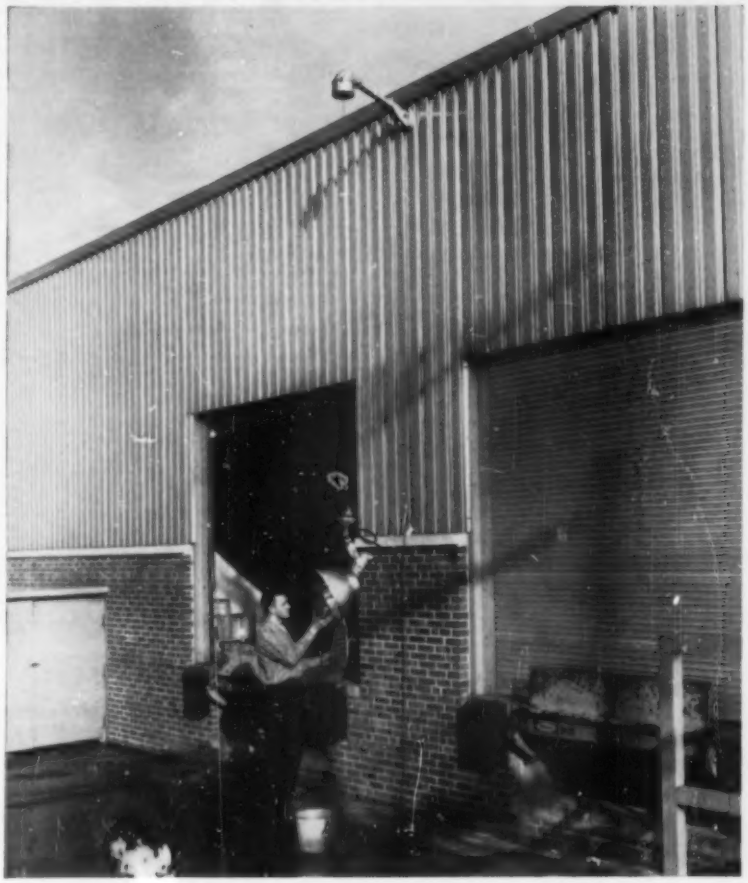

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(*Continued from page 37A*)

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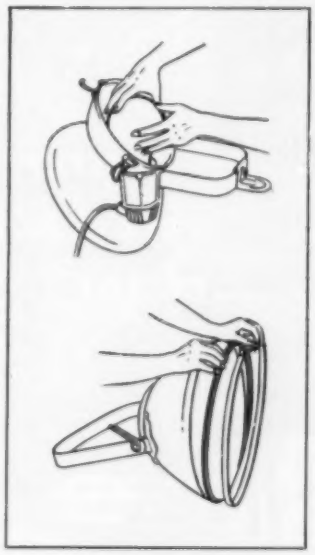
New Steber Series 5000—Rear Lamped Floodlights—are designed to meet NEMA Specifications FL6-210, Group B, Types I, II, III, IV and V. They accommodate G-48, 1500 watt, PS-52, 750-1000-1500 watt incandescent and 400-700 watt Mercury Vapor lamps.



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2. Finned, cast aluminum neck and cap for maximum heat dissipation
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6. Positive grounding—both during operation and servicing

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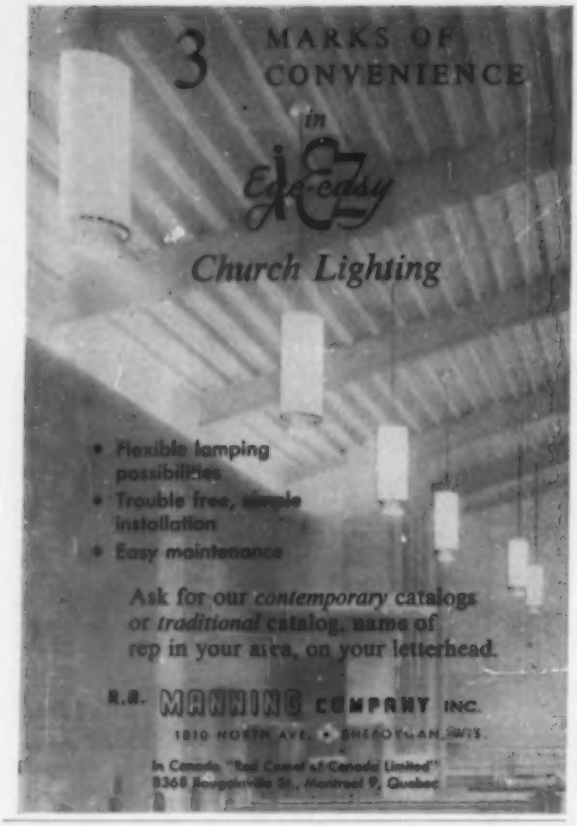
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#220—For Bulb-Tee, Tee Bars, other flanged structurals.

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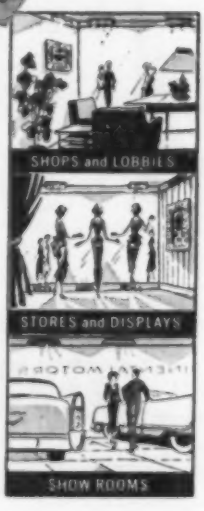

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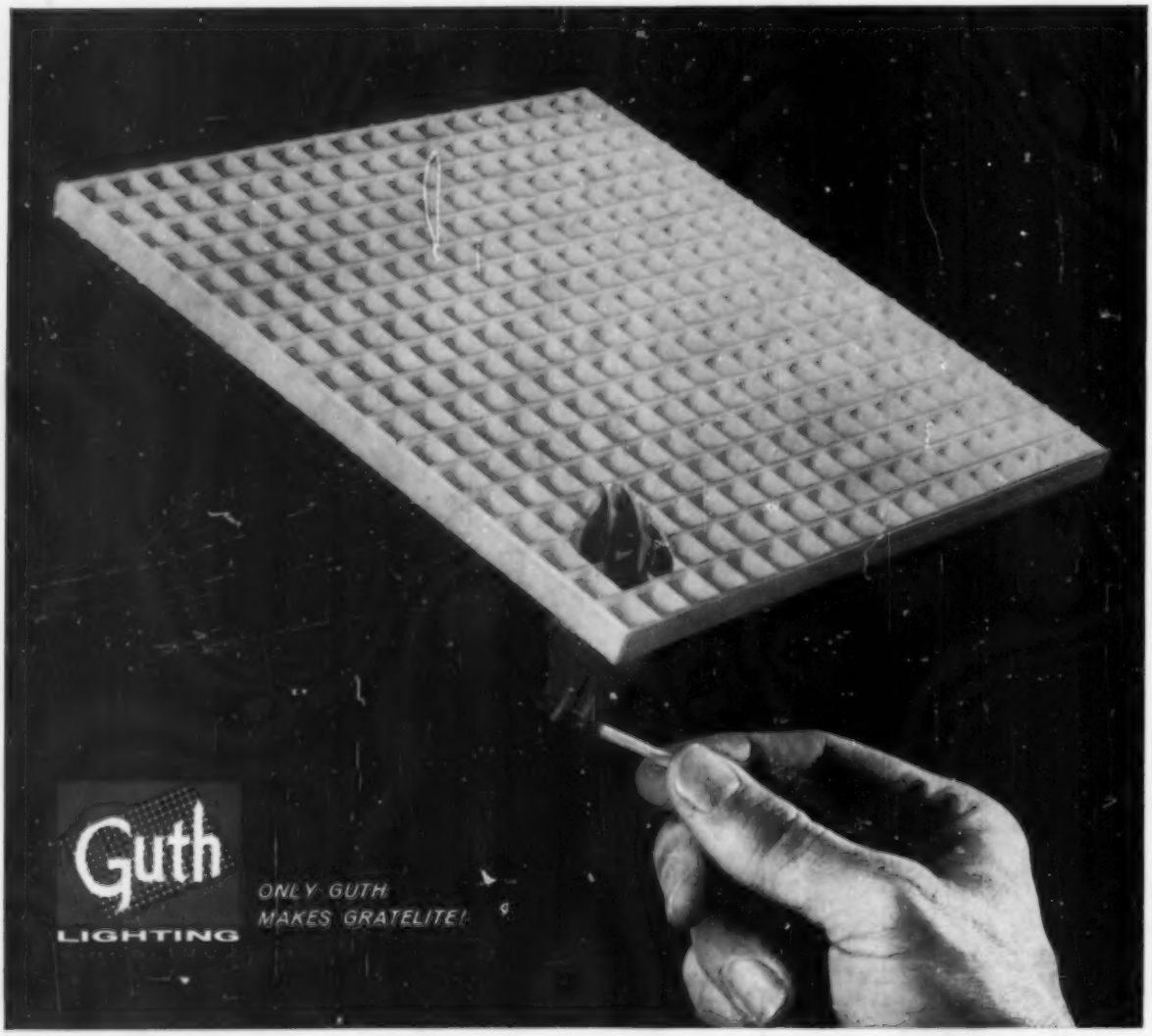
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